http://www.avionteq.com/Ruska-GE-Sensing-AeroCal-7750I-Laboratory-Air-Data-Test.aspx

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RUSKA 7750i

Air Data Test Set

Users Manual

PN 3963351
November 2010
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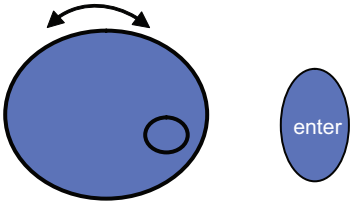
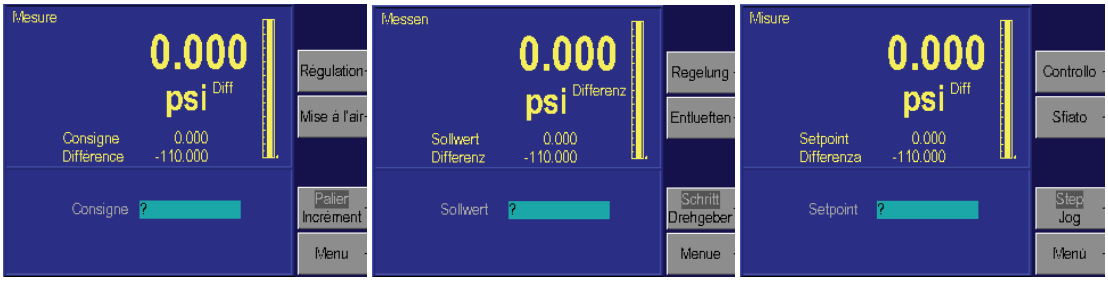
7750i – Change Language

Hold mode key for 5 seconds





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Chapter 1
General Information

Introduction

This manual contains operation, routine and preventive maintenance instructions for the RUSKA 7750i Air Data Test Set (ADTS) manufactured by Fluke. This section of the manual provides general information about the ADTS and presents its features and options.

How to Contact Fluke

To order accessories, receive operating assistance, or get the location of the nearest Fluke distributor or Service Center, call:

- Technical Support USA: 1-800-99-FLUKE (1-800-993-5853)
- Calibration/Repair USA: 1-888-99-FLUKE (1-888-993-5853)
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31-402-675-200
- China: +86-400-810-3435
- Japan: +81-3-3434-0181
- Singapore: +65-738-5655
- Anywhere in the world: +1-425-446-5500

Or, visit Fluke's website at www.fluke.com.

To register your product, visit http://register.fluke.com.

To view, print, or download the latest manual supplement, visit http://us.fluke.com/usen/support/manuals.

Safety Information

Safety Summary

The following are general safety precautions that are not related to any specific procedures and do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during equipment operation and maintenance to ensure safety and health and protection of property.

Keep Away From Live Circuits

Operating personnel must at all times observe safety regulations. Do not replace components or make adjustments inside the equipment with the voltage supply connected. Under certain conditions, dangerous potentials may exist when the power control is in the off position due to charges retained by capacitors. To avoid injuries, always remove power from, discharge, and ground a circuit before touching it.

Do Not Service or Adjust Alone

Do not attempt internal service or adjustment unless another person capable of rendering aid and resuscitation is present.

Resuscitation

Personnel working with or near dangerous voltages shall be familiar with modern methods of resuscitation. Such information may be obtained from your local American Medical Association.

Electro Static Discharge Sensitive Parts

⚠ Caution

Electrostatic discharge sensitive (ESDS) is applied to low power, solid-state parts which could be damaged or destroyed when exposed to discharges of static electricity. Maintenance personnel are often not aware that an ESDS part has been damaged or destroyed because electrostatic discharges at levels less than 4,000 volts cannot be seen, felt, or heard.

Compressed Gas

Use of compressed gas can create an environment of propelled foreign matter. Pressure system safety precautions apply to all ranges of pressure. Care must be taken during testing to ensure that all pneumatic connections are properly and tightly made prior to applying pressure. Personnel must wear eye protection to prevent injury.

Personal Protective Equipment

Wear eye protection approved for the materials and tools being used.

Inert Gases

Operation of pressure equipment may be accompanied by the discharge of inert gases to the atmosphere. The result is a reduction of oxygen concentration. Therefore, it is strongly suggested that exhaust gases not be trapped in the work area.

⚠ Warning

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

The AC plug, switch and power cord shall remain readily accessible for the operation.

Symbols Used in this Manual

In this manual, a **Warning** identifies conditions and actions that pose a hazard to the user. A **Caution** identifies conditions and actions that may damage the ADTS or the equipment under test.

Symbols used on the RUSKA 7750i Air Data Test Set (ADTS) and in this manual are explained in Table 1-1.

Table 1-1. Symbols

Symbol	Description
~	AC (Alternating Current)
⏚	Earth Ground
⚠	Important Information: refer to manual
⚠	Shock Hazard
	Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information.
CE	This equipment meets the requirements of all relevant European safety directives. The equipment carries the CE mark.

General Information

The RUSKA 7750i ADTS uses force-balanced, fused-quartz Bourdon tube technology to provide the precise measurement of pressure. During normal operation, the ADTS performs in either Measure mode or Control mode.

In Control mode, the ADTS simultaneously measures and controls pressure. Control mode is commonly used in the calibration and testing of air data computers, altimeters, airspeed indicators, rate of climb indicators, pressure gauges, transducers, pressure switches, and production pressure instruments.

In measure mode, the ADTS measures pressure. It can be used to monitor barometric pressures, vacuum systems, and differential pressure devices.

The RUSKA 7750i has two full-scale pressure ranges and two pressure controllers integrated into one instrument.

Features

The following features are available on all RUSKA 7750i ADTSs.

Fused-Quartz Bourdon Tube Technology

RUSKA's force-balanced, fused quartz Bourdon tube sensor makes use of the stability, high elasticity, low hysteresis, and excellent fatigue strength of fused quartz. This time-proven technology eliminates the need for gear trains, bearings, shafts, and other moving parts that can wear out or introduce hysteresis or dead band into the process.

NIST Traceability

All ADTS's are calibrated using RUSKA's deadweight gauges that are directly traceable to the National Institute of Standards and Technology (NIST). NVLAP Accredited calibration reports are provided standard with the instrument.

Universal Power Supply

The ADTS's universal power supply accepts AC voltages between 100 – 120 VAC and 220 – 240 VAC. To "reconfigure" the ADTS for use in another country, the user simply changes the power cord.

Measure While Control

The ADTS simultaneously digitally displays the commanded pressure, the actual pressure, and the difference between the two. A bar graph indicates how close the actual pressure is to the commanded pressure, as well as how close the commanded pressure is to the ADTS's full-scale pressure.

Friendly Display

The ADTS's color active matrix TFT display combines a bright, low-glare readout with a wide viewing angle. During normal operation, the measured pressure is easily visible from a distance of 10 feet (3 meters).

Adjustable Pressure Display

The pressure display may be adjusted to show one decimal greater than or less than the default resolution.

Ease of Operation

An intuitive, menu-driven interface makes the ADTS easy to use. Frequently used selections such as the units of measure are restored to memory each time the ADTS powers up.

Easily Programmable

The ADTS's powerful microprocessor provides the basis for smart electronics. With a few simple keystrokes, the user can set limits on the system pressure, create unique units of measure, and more.

Modular Design

The sensing element, pneumatics, electronics, and user interface are separated into modules, making maintenance faster and easier.

Attractive Desktop Packaging

A sturdy aluminum case houses all of the ADTS's pneumatics, electronics, and user controls. With the optional rack mount kit; this standard 19" EIA chassis fits easily into a rack mount system.

Power On Self-Test

Upon power-up, the ADTS quickly tests its hardware and software. After the ADTS completes this test, the user can select more extensive self-tests for the pneumatics and electronics.

Ease of Calibration

Calibration may be performed either remotely or entirely from the front panel. No disassembly is required, and there are no potentiometers to tune. Only a five-point calibration is required to fully characterize the Ps range, and a seven-point calibration for the Qc range.

Automatic Zero Adjust

At the user's request, the ADTS's software automatically performs the zero adjustment, with no potentiometers to tune.

Automatic Head Correction

The ADTS automatically corrects for head pressure between the ADTS and the device under test (DUT), taking into account the density of the test gas; e.g., air or nitrogen.

Choice of Medium

Although the ADTS is not sensitive to the type of gas used within the system, the user can select either instrumentation air or nitrogen, allowing the ADTS to automatically make pressure head corrections.

Choice of Display Units

Standard units include inHg at 0 °C and 60 °F, kilopascals, bar, psi, inH_2O at 4 °C, 20 °C, and 25 °C, kilograms per square centimeter, mmHg, cmHg at 0 °C, and cmH_2O at 4 °C. Altitude and airspeed units include feet, meters, mach, knots, and kilometers per hour. In addition to these predefined units, two user-defined units are programmable.

Communications Interface

The ADTS includes standard RS-232 serial and IEEE-488 interfaces. The user's computer communicates with the ADTS through the Standard Commands for Programmable Instruments (SCPI) protocol.

Standard Equipment & Options

A standard ADTS includes this manual and a power cord. The following options are also available.

Rack Mount Kit: This 6.969" kit meets ANSI/EIA requirements for a 4U, 19" rack mount kit.

Lines and Fittings Kit: This kit contains the pressure and vacuum lines and fittings to connect the RUSKA 7750i to the optional Fluke vacuum pump and to a gas bottle regulated with 1/4 NPT fittings. Additionally, this kit contains two flexible hose assemblies, one for the Ps terminating to a female AN6 fitting and one for the Qc pressure port terminating to a female AN4 fitting.

Additional Power Cords: Additional power cords are available for most countries. All options are summarized in Table 1-1. To order these items, please contact Fluke Calibration in the U.S. at (713) 975-0547.

Table 1-2. RUSKA 7750i ADTS - Options List

Option	Part Number
LabView Driver (National Instruments)	Downloadable from World Wide Web
Rack Mount Kit — Cabinets 18 – 24 inches deep	3879677
Lines and Fittings Kit	3882962
Vacuum Pump 115/220 VAC 50/60 Hz	3917819
Power Cord, USA and Canada	284174
Power Cord, Central Europe	769422
Power Cord, India	782771
Power Cord, Japan	3898323
Power Cord, Australia/New Zealand	658641

Chapter 2
Theory of Operation

Introduction

The ADTS's power supply, electronics, pneumatics, and sensor combine to form a complete, stand–alone, measure and control instrument. This Chapter of the manual describes the ADTS's component modules (Figure 2-1) and provides a general discussion of each. The RUSKA 7750i has two pneumatic control and two primary transducer modules.

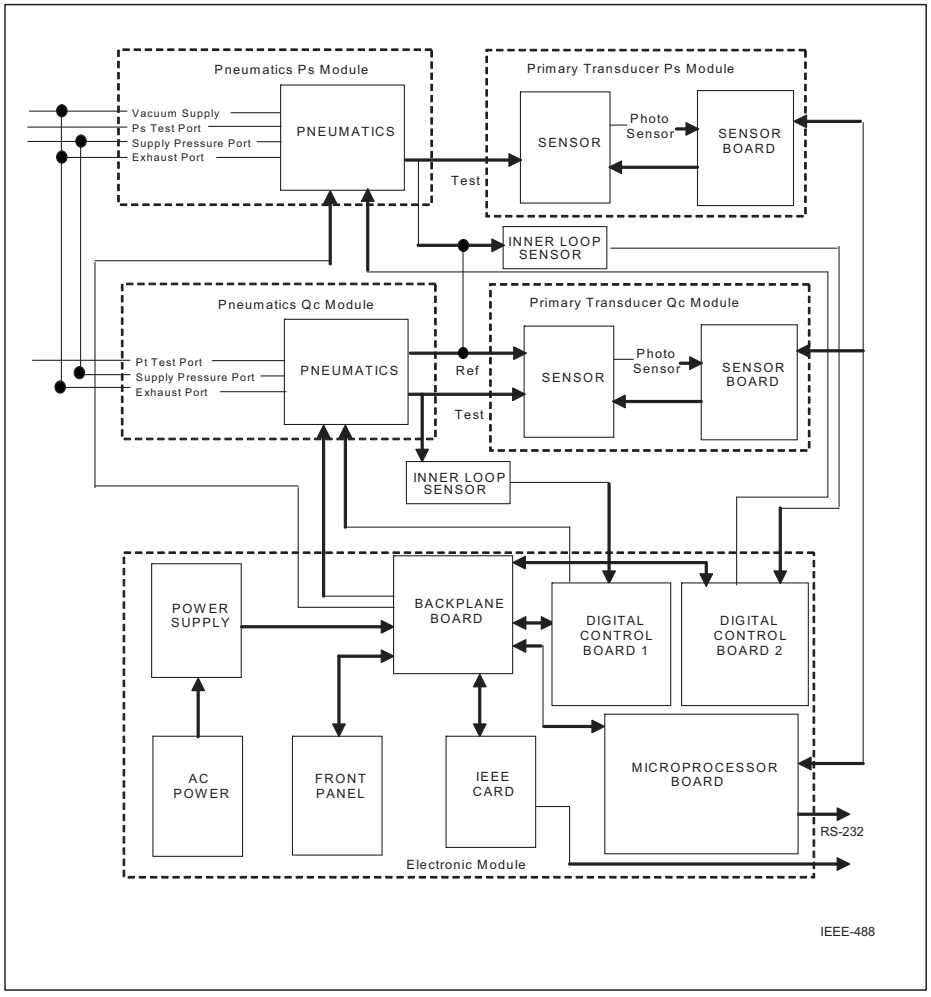

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Figure 2-1. ADTS Block Diagram

Power Supply

The ADTS's universal power supply accepts AC voltages from 100 – 120 VAC and 220 – 240 VAC at 50 / 60Hz. This quad-output supply produces +5 VDC, +/-12 VDC, and 24 VDC, which are distributed to the Control and Backplane Boards.

Electronics Module

Back-Plane Board

The Back-plane Board is used to interconnect all of the plug-in electronic boards and distribute power. The Microprocessor Board, the Digital Control Board, and the IEEE-488 Interface all plug into the Back-plane Board. The Front Panel communicates with the Microprocessor Board via cables. The Sensor Board communicates with the Microprocessor board through an internal RS-485 serial communication bus.

Microprocessor Board

All of the ADTS's software resides in nonvolatile, programmable, read-only memory (Flash EPROM) on the Microprocessor Board, which plugs directly into the Back-plane Board. This software contains all of the instructions that operate the ADTS, as well as the conversion factors that the ADTS uses to translate the internal pressure unit-of-measure of kPa into the units selected by the user. These factors are given in Table 2-1.

Data that is subject to change after the ADTS leaves the factory is held in electrically erasable, programmable, read-only memory (EEPROM). This includes the current units of measure, the coefficients from the zeroing process, the current pressure medium, calibration coefficients, and the conversion factors for the four user-defined units of measure.

When the ADTS powers up, its software is loaded into random access memory (RAM), also on the Microprocessor Board. At the same time, the values stored in EEPROM Board are restored to memory.

Another important component on the Microprocessor Board is the lithium battery. The battery continuously updates the ADTS's date and time, even when the unit is powered down. This battery has a varying life. If the instrument is left on 24 hours a day, it will last 5 to 10 years. If the instrument is stored, it may only last one year.

The Microprocessor Board also supports the RS-232 serial interface that allows the user's computer to communicate with the ADTS.

Unless specified otherwise, conversion factors are based on ANSI 268-1982.

Table 2-1. Conversion Factors

Symbol	Description	Conversion Factor
InHg	inches of mercury (0 °C)	= kPa x 0.2952998
InHg	inches of mercury (60 °C)	= kPa x 0.296134
kPa	kiloPascals	= kPa x 1.0
bar	bar	= kPa x 0.01
Psi	pounds per square inch	= kPa x 0.1450377
cmH_2O	centimeters of water (4 °C)	= kPa x 10.19744
inH_2O	inches of water (4 °C)	= kPa x 4.014742
kg/cm2	kilograms per square cm	= kPa x 0.0101972
mmHg	millimeters of mercury (0°C)	= kPa x 7.500605
cmHg	centimeters of mercury (0 °C)	= kPa x 0.7500605
knots	Indicated airspeed	per NASA TN D-822
km/hr	kilometers per hour	= knots x 1.852
Feet	feet of altitude	per MIL-STD-859A
meters	meters of altitude	per MIL-STD-859A
user1	user defined	= kPa x User defined
user2	user defined	= kPa x User defined
Pa	user defined (Pascals)	= kPa x 1000.0
hPa	user defined (hectopascal)	=kPa x 10.0
%FS	user defined (percent of full scale)	

Digital Control Board

The Digital Control Board plugs directly into the Back-plane Board. This board reads a high-speed silicon strain gauge pressure transducer, PDCR, connected to the pressure generation point. A digital controller on the board drives two solenoids in the pneumatics section to form a high-speed, closed loop controller. There are two digital control boards in the RUSKA 7750i ADTS.

IEEE-488 Interface

The ADTS's IEEE-488 (GPIB) interface card, which plugs directly into the Back-plane Board, provides the ADTS with an IEEE-488 interface. This interface allows the user to automate the measurement and control processes.

Front Panel

The Front Panel contains the active matrix TFT color display, rotary knob and rubberized keys used to operate the ADTS.

Pneumatics Module

The ADTS's pneumatics module includes an absolute mode pneumatic module for the Ps channel and a differential pneumatic module for the Qc channel. The output of the Ps channel controls the pressure to the reference of the Qc differential channel. The Total Pressure (Pt) value is derived from the addition of the Ps and Qc sensor values.

The valves and transducers that make up the pneumatics module are shown in Figure 2-2.

In the sections that follow, the Zero, Isolation, Apply and Release valves are all 24-volt, DC solenoid valves that are either open or closed depending on the ADTS's operational mode. Their behavior is summarized in Table 2-2.

Table 2-2. Solenoid Valves States

Valve	Measure Mode	Vent	Control Mode	Zeroing
Ps Test	Open	Open	Open	Closed
Ps Zero	Closed	Closed	Closed	Open
Ps Vent	Closed	Open	Closed	Closed
Ps Apply	Closed	Closed	Modulate	Closed
Ps Release	Closed	Closed	Modulate	Closed
Pt Test	Open	Open	Open	Closed
Pt Equalize	Closed	Open	Closed	Open
Pt Apply	Closed	Closed	Modulate	Closed
Pt Release	Closed	Closed	Modulate	Closed

Measure Mode Pneumatics

Figures 2-2 and 2-3 summarize the Pneumatics of the ADTS.

Qc Reference

The Reference side of the true differential Qc sensor is internally tied to the test port of the Ps sensor.

The Reference side of the Qc sensor is isolated from the Pt Test Port by a solenoid valve that is closed during the ADTS's Measure and Control modes. When the user commands the ADTS to perform the zeroing process, the solenoid automatically opens, and the pressures on the Reference and Test Ports of the Qc sensor become equal. On the permanent absolute Ps sensor, the Ps zeroing valve allows a vacuum to be pulled onto the Ps test port allowing the instrument to zero at a low vacuum level.

Test Port

The Test Port connects the DUT to the Pneumatics Module. The RUSKA 7750i has two test ports, one for the Ps and for the Pt channel. The Test Port is isolated from the DUT by a normally closed solenoid valve that is open during the ADTS's Measure, Control and Vent modes, and closed during the zeroing process.

Each Test Port is protected by a relief valve.

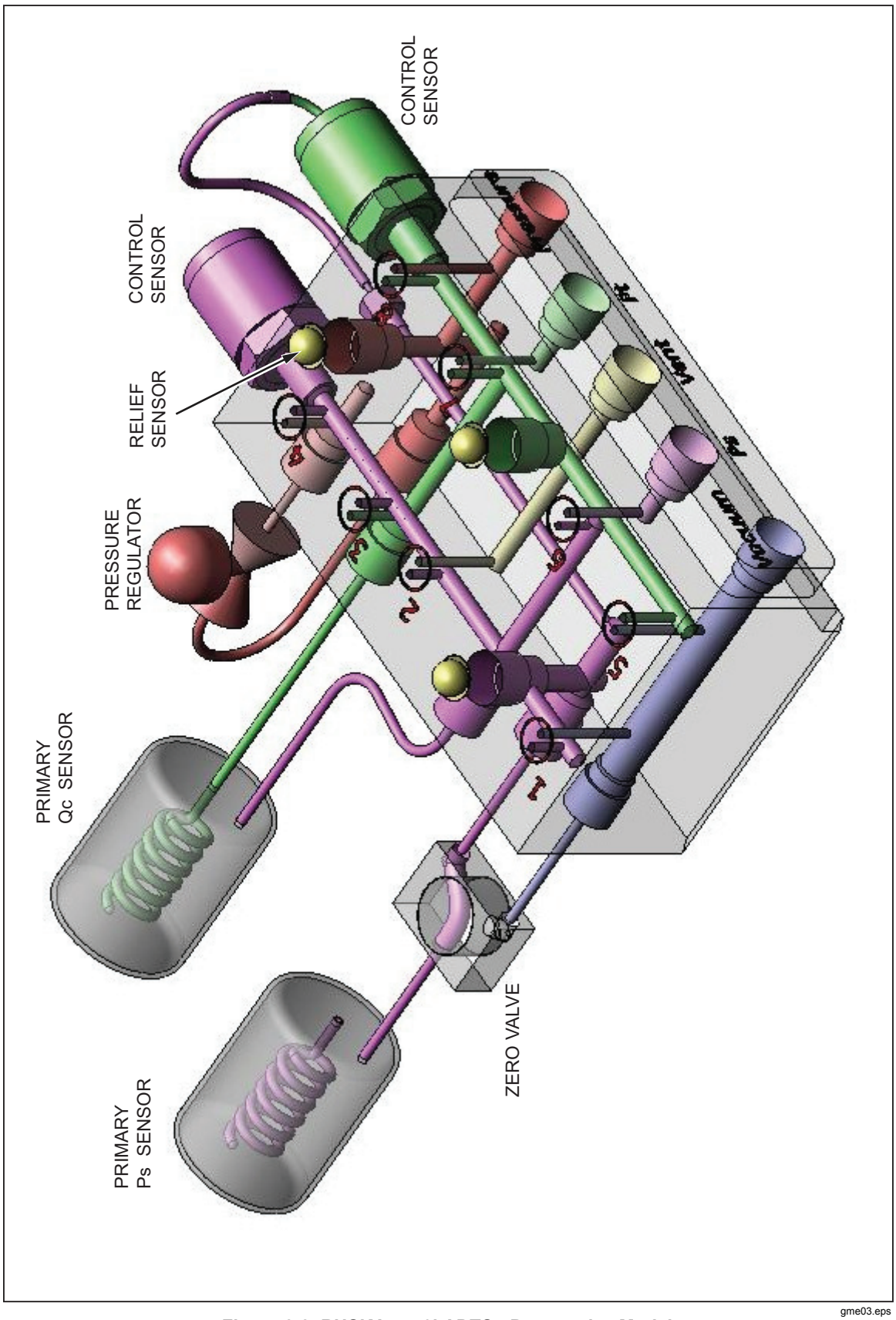

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Figure 2-2. RUSKA 7750i ADTS - Pneumatics Model

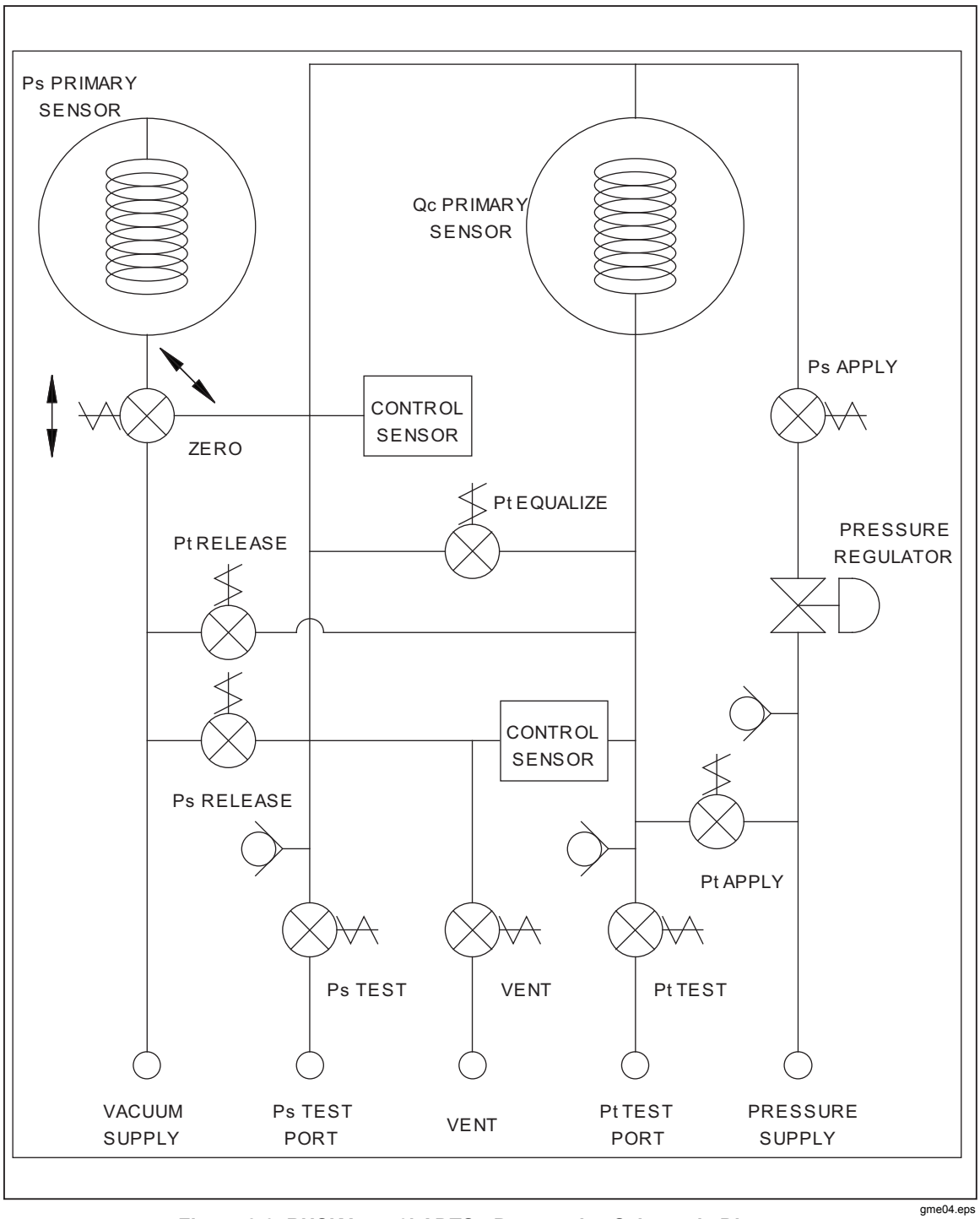

Figure 2-3. RUSKA 7750i ADTS - Pneumatics Schematic Diagram

Go to Ground or Vent Procedure

The Go-To-Ground is implemented as a multi-step procedure:

a. Control Ps to close to Atmosphere and Qc to zero at the current rate.

b. Measure actual atmospheric pressure.

c. Control Ps to measured atmosphere.

d. Open Ps Vent and Pt Equalize valves.

Control Mode Pneumatics

Pressure Supply Port

The Pressure Supply Port connects the user's regulated gas supply to the Pneumatics Module. Please refer to Appendix A for gas specifications and supply pressure limits. The supply pressure is connected to the right-hand port of the rear chassis. This regulated pressure should be set to the full-scale Pt range + 10 psi (0.7 bar). Internally, this pressure is regulated down further to supply the Ps control manifold.

Vacuum Supply (Exhaust) Port

The system can be operated with a single vacuum pump. Select a vacuum pump with the test port volumes and system slew rates in consideration. A high capacity vacuum pump is required to allow the unit to be zeroed. The minimum requirements are noted in Appendix A. The vacuum pump must be fitted with an auto-vent solenoid valve that vents the vacuum to atmosphere if the power to the pump is interrupted.

Pressure Control

Pressure control is performed by a dual-loop control system. The inner loop is a digital loop using a high frequency response silicon strain gauge sensor, a digital controller, and two pulse-width modulated solenoids. The two solenoids either add gas to the test port or remove it. The outer loop provides closed-loop control, based on feedback from the quartz Bourdon tube and an analog output setting which provides the desired set-point for the inner loop.

Control Strategy

Inner vs. Outer loops

The inner loop accepts a signal from the outer loop and uses this signal as the pressure set point. The inner loop uses a high frequency response strain gauge sensor as its reference. The frequency response of this transducer allows for high-speed modulation of the solenoids. This sensor is aligned to the high accuracy quartz sensor when the system is Auto-tuned.

The outer loop is a lower frequency response, analog-digital loop. The outer loop uses a calibrated, forced-balanced sensor. This sensor is used to monitor the pressure of the system. The results are used for the displayed pressure. The outer loop is responsible for adjusting the signal sent to the inner loop to compensate for temperature and time drifts associated with the inner loop sensor.

Transducer Module

Quartz Bourdon Tube Sensor

The quartz Bourdon tube sensor is mounted in a machined aluminum housing. The sensor consists of a helical quartz tube with a mirror affixed to one end, as shown in Figure 2-4.

A rigid beam is attached transverse to the axis of the helical tube. Attached to both ends of this beam are electromagnetic coils. Mounted beneath the coils are permanent magnets. A lamp assembly directs light through a quartz window onto the mirror affixed to the helical tube, as shown in Figure 2-4. The mirror reflects the light back through the window and strikes two matching photodiodes. When there is zero pressure differential across the helical tube, the photodiode assembly is mechanically adjusted so that the light spot is centered between each photocell. In this "zero position," the outputs of the two photodiodes provide energy used to maintain the quartz assembly in its zero position; thus, a force balance is created.

As pressure is applied in the helical tube, the entire apparatus attempts to rotate. This causes the mirror to move the reflected light spot to shine more on one photodiode than the other. The Sensor Board (see Chapter 2, Sensor Board section) then responds by changing the current to the electromagnetic coils that, through interaction with the permanent magnets, force the helical tube to return to its zero position. The amount of current required to do this is proportional to the pressure applied across the helical tube. Thus, the pressure is determined by the amount of current required to return the helical tube to its zero position.

On the Absolute Ps sensor, the process is similar, except that the Bourdon tube is permanently evacuated and sealed at the factory, and the test pressure is applied to the sensor case. With this configuration, all test pressures are measured with respect to vacuum.

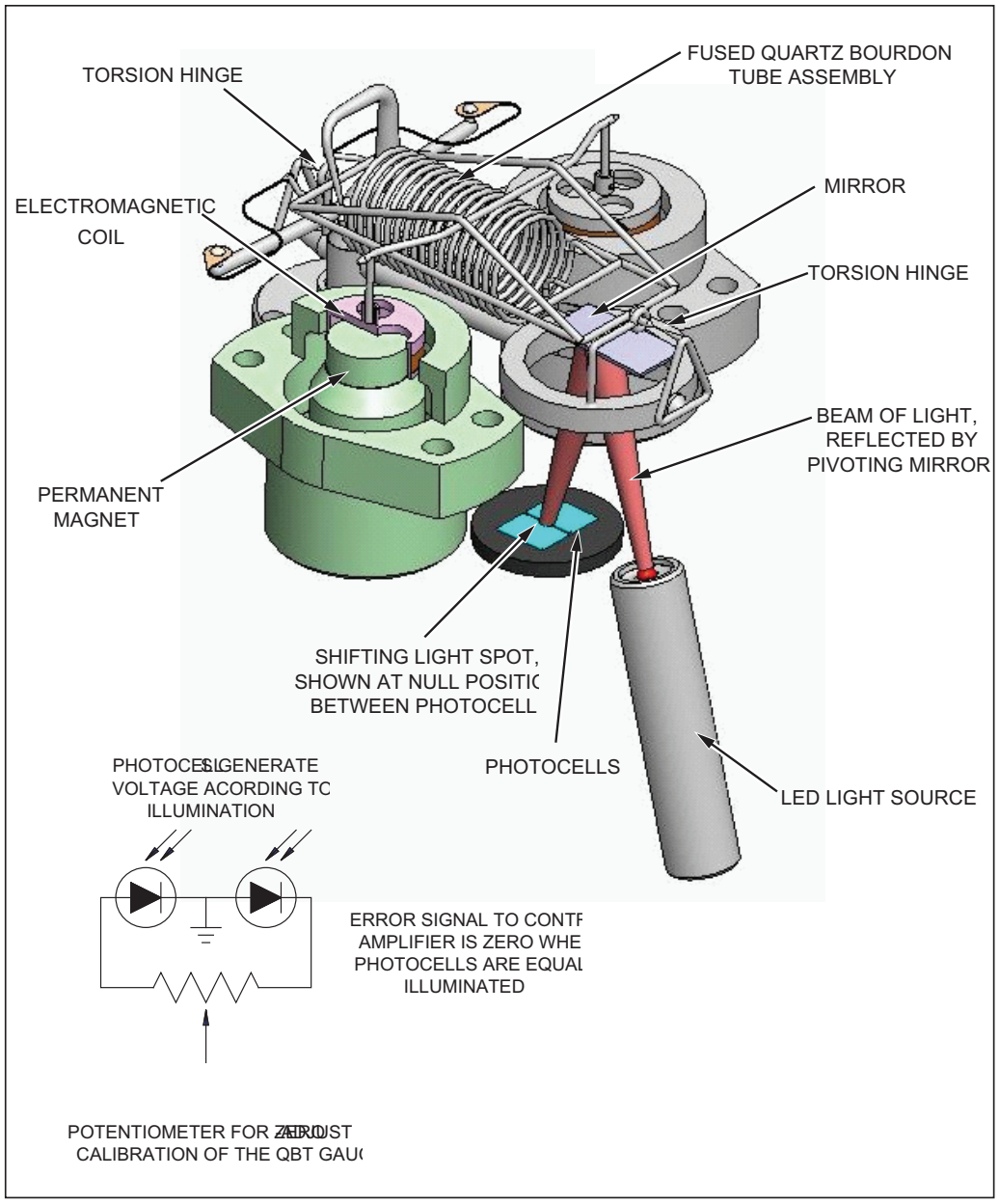
TORSION HINGE
FUSED QUARTZ BOURDON TUBE ASSEMBLY
ELECTROMAGNETIC COIL
MIRROR
TORSION HINGE
BEAM OF LIGHT, REFLECTED BY PIVOTING MIRROR
PERMANENT MAGNET
SHIFTING LIGHT SPOT, SHOWN AT NULL POSITIC BETWEEN PHOTOCELL
PHOTOCELLS
LED LIGHT SOURCE
VOLTAGE ACORDING TC ILLUMINATION
ERROR SIGNAL TO CONTF AMPLIFIER IS ZERO WHE PHOTOCELLS ARE EQUAL ILLUMINATED
CALIBRATION OF THE QBT GAU

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Figure 2-4. Photocell/Light Spot

Sensor Board

The Sensor Board monitor the quartz Bourdon tube pressure sensor, reference vacuum sensor (Ps channel), and oven temperature sensor. The vacuum and temperature sensors are aligned at the factory, and are utilized by the firmware.

The sensor board is also used to control and maintain the sensor housing at 50 °C.

Linearization Term

As described in the previous section, the relationship between the pressure being measured and the current required to keep the quartz Bourdon tube in its zero position is the main principle behind the operation of the ADTS's sensing element.

Ideally this pressure-current relationship would be a linear equation of the form

$$I = kP,$$

where I is current, k is a constant of proportionality, and P is pressure. However, due to certain mechanical characteristics of the helical tube and its supporting structure, this pressure-current relationship is slightly nonlinear. The nonlinear portion of this pressure-current relationship closely follows the form of a second order polynomial, or

$$I = aP^2 + bP + c,$$

where again P is pressure and a, b, and c are coefficients generated during the calibration procedure as discussed below.

When the user performs a three-point calibration, the ADTS's software creates the three coefficients based on the user's zero, mid-point, and full-scale adjustments. From then on, the nonlinear term given above is subtracted from the total pressure-current curve to achieve the desired linear pressure-current relationship.

On the RUSKA 7750i, multiple quartz sensor ranges are used in order to provide the percent of reading specification. In these instruments, a total of three points per range with one point shared between two ranges is required. Therefore, a 5-point calibration is performed to fully characterize the quartz sensors.

Software

The ADTS is a digital, software-based instrument. The controlling software uses a PID algorithm and allows for user-definable units and onboard programming. The software control loop is a digital outer loop with a high-speed inner loop.

Software Safety Controls

Preventing Operator Errors

The operator is required to verify a change to Control mode or Vent mode by pressing the Enter key. Additionally, the control set-point is set to zero on power-up or when any of the limit errors occur.

Pneumatic Errors

The ADTS continually monitors the pressure for low, high and slew (rate of change) limits. When these limits are exceeded, the ADTS is returned to Measure mode, shuts off the apply and exhaust control valves, and an error message is generated. Additionally a vent limit may be set. The ADTS will go to Vent mode when the pressure exceeds this limit.

Shut Offs

Measure mode can be entered at any time by pressing the Measure key on the main keypad with no further acknowledgment required. The ADTS will turn off the controller.

Oven Control

The oven temperature is controlled via a pulse-width modulated signal. The time the heater is on can be varied from 0% to 100%. The pulse-width at startup is initialized to the previous value that was stored in battery-backed CMOS RAM.

The oven control is a PID controller updated approximately every 7 seconds. The sensor readings are accessed by pressing MENU | MENU | DISPLAY | TEMP. The high accuracy quartz sensor is housed in a temperature-controlled oven. There is a 3-hour warm-up time required prior to the ADTS operating at its optimum precision. The user can verify when the instrument is thermally stable by viewing the MENU | DISPLAY screen and verifying that the temperature is at 50 ºC. In addition to the temperature, this screen will show the duty cycle of the oven.

When operating the system in either a very cold or hot environment, if the oven in unable to maintain the temperature of the internal oven, the ADTS will generate an Oven Control Failure error messages. The operator can review the temperature and duty cycle of the oven by pressing the MENU | MENU | DISPLAY | TEMP keys. The unit must have been warmed up for a minimum of 3 hours prior to determining the condition of the oven temperature control. The temperature of the sensor should be controlled to 50 ºC. The Duty Cycle indicates the amount of time (in units of percentage) that the oven control is turned on in order to maintain the oven at the proper set point of 50 ºC. A unit that is operating properly, after it has fully warmed up, should indicate a sensor temperature of 50 ºC and a duty cycle between 10% to 90%.

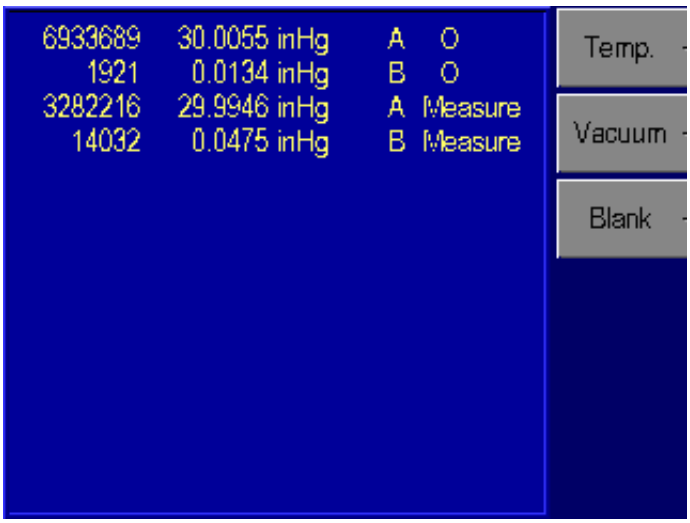

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Figure 2-5. Menu | Display - Menu

Pressure Reading and Correction

The sensor's analog output is processed by an analog-to-digital circuit. This output is corrected for the applied effects listed below.

The output is linearized and the resulting pressure value is corrected for the variations in head pressure, vacuum, case effect, and oven temperature effects.

The following equations are used to adjust and correct the pressure signal.

Zero Coefficients

CsH — Zero correction for High FSR (Full-Scale Resistors) Value is in counts (7,381,975 = full scale of current sensor).

CsL — Zero correction for Low FSR. Value is in counts (7,381,975 = full scale of low FSR)

HsZ — Hardware zero correction. (0 to 4095, center is 2048).

SsZ — Zero corrections scaling factor. Ratio of High FSR to Low FSR. Used only when Case Effect Coefficient or Oven Temperature Coefficient are non-zero.

s = 0 for high range sensor, s = 1 for low range sensor.

Range Coefficients

KnF — 0 = Range Unused
4 = Valid High FSR Range
5 = Valid Low FSR Range

Kn0, Kn1, Kn2 Calibration constants for range

$$B = \frac{K_{n2}}{2^{48}} * A^2 + \frac{K_{n1}}{2^{24}} * A + K_{n0}$$

Where A is the zero corrected counts (7,381,975 = full scale of current range) and B is the calibrated counts (7,381,975 = full scale of current sensor)

KnH — Zero corrected counts for upper limit of range. When the zero corrected counts from the A/D exceed this value the next higher range will be used (if possible). (7,381,975 = full scale of current range)

KnL — Zero corrected counts for lower limit of range. When the zero corrected counts from the A/D are below this value the next lower range will be used (if possible). (7,381,975 = full scale of current range)

n = Range number (1 – 4 for high range sensor, 5 – 8 for low range sensor)

Chapter 3
Installation

Introduction

This section of the manual discusses initial installation for the RUSKA 7750i ADTS. Installing the ADTS involves connecting the supply and test pressure tubing, powering up the unit, and configuring the system through the front panel.

Unpacking the ADTS

Carefully unpack all components, checking for obvious signs of damage. The shipment contains the following items:

1. RUSKA 7750i ADTS,
2. Power cord and fittings kit,
3. Users manual,
4. Calibration report,
5. User-specified instrument options.

If necessary, report any shipping damage to the freight agency. Remove all shipping and packing materials (including the shipping plugs) from all components. If possible, save the packing materials for future shipping needs.

Finally, install the ADTS in a location that meets the requirements listed in Table 3-1.

Note

The ADTS should be handled in such a way as to minimize mechanical shocks or vibration during installation or use. It should be mounted on a rigid bench or in a sturdy 19"-wide rack, (cabinets 18" to 24" deep). An optional Rack-Mounting Kit is available — Part Number 7250-903. Although the zeroing process will compensate for a slightly unlevel mounting, the ADTS should be mounted to within 5° of level.

Table 3-1. General Specifications and Parameters

Parameter	Value
Operating Humidity	5% – 95%RH, non-condensing
Storage Humidity	None*
Operating Temperature	18 °C – 36 °C
Storage Temperature	-20 °C to 70 °C
Electrical Power	100 – 120/220 – 240 VAC
Power Consumption	150 W (maximum)
Warm-up Period	< 3 hrs

*If there is any condensation when storing the ADTS, it must be thoroughly dried before power is applied. It is also recommended to connect the reference port to the test port and evacuating these simultaneously to remove any moisture from the sensor.

Cautions

The following cautions should be heeded at all times to ensure safe operation of the ADTS.

⚠⚠ Warning

Never operate the ADTS with the cover removed. The power supply has internal voltages near 400 volts.

For each channel, never apply more than 120% of the ADTS's channel full scale as a pressure supply. The pressure supply must be regulated and meet all of the criteria stated in Appendix A of this manual.

Never apply more than 110% of the ADTS's full scale to the test port. Never try to control while a pressure source is connected to the test port.

Do not expose the instrument to thermal and mechanical shock, or vibration. This may affect performance and require re-zeroing.

See Chapter 1, Safety Information.

Powering Up the ADTS

Plug the power cord supplied with the ADTS into the power connector on the back panel first.

⚠ Caution

Grounding for the ADTS is provided through the power cord.

Then plug the power cord into a receptacle rated for any AC voltage between 90 and 260 volts. If a different power cord is necessary for your receptacle, consult Table 1-2 for available power cords.

Finally, turn on the ADTS by toggling the power switch on the back panel. When the MEASURE screen appears on the display, the front panel will be fully operational.

Observing the ADTS's Full Scale Rating

The full scale pressure range of each channel of the ADTS is noted on a label on the front panel of the instrument. The label denotes the pressure range for Ps and for the Qc channel.

Pneumatic Connections

The following sections discuss each port. All ports are 1/4 inch NPT pipe fittings. See Figure 3-1. Remove all plastic shipping plugs from the back panel pneumatic ports.

Pressure Supply Port

A single regulated pressure supply source of clean, dry nitrogen or air should be supplied to the instrument. Shop air should not be used. Refer to Appendix A for supply port gas purity and pressure regulation requirements.

Tubing must be of at least 1/8 inch (3 mm) inside diameter and of a sufficient wall thickness for the pressure.

Supply Vacuum Port

A single vacuum pump is required to operate the ADTS. Supply vacuum lines must have minimum restrictions. Tubing should have a minimum I.D. of 1/4 inch. It is highly recommended to have vacuum lines with outside dimensions of 1/2 to 3/4 inch. Additionally, the length of the vacuum hose should be minimized for optimum performance. It is also very important to install an auto-vent valve to the vacuum pump to vent the vacuum to atmosphere when the pump is turned off.

To zero the Ps channel, a vacuum pump capable of producing a vacuum level of 200mTorr or less at the sensor reference port is required. See Appendix A for vacuum pump requirements.

Ps & Pt Test Ports

The device(s) under test is connected to the test port. The ADTS controller is designed to operate within its specification limits into load volumes from 5 in^3 to 60 in^3 (80 to 1000 cc). Excessive leaks in the test volume will cause measurement errors in the device under test and may possibly affect control stability. Tubing connected from the test port to the load volume should have an internal diameter greater than 1/8 inch (3 mm).

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Figure 3-1. RUSKA 7750i Back Panel

Vacuum Sensor

The ADTS has a vacuum sensor connected to the Ps sensor. This sensor is used to zero the Ps channel.

Chapter 4
Local Operation

Local Operation

This section of the manual describes operation of the ADTS using the front panel (local interface).

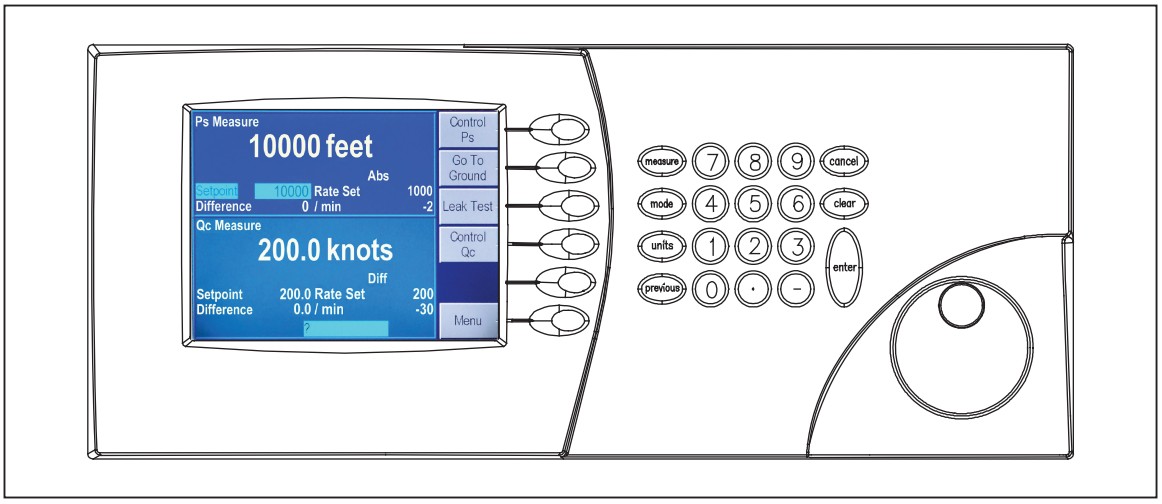

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Figure 4-1. RUSKA 7750i Front Panel

1. Color TFT display shows the system status and menu options.
2. Function keys — the label shown in the display identifies their function, which will change based on the screen of operation. Referred to in this manual as [F1] through [F6], (top key considered to be F1, bottom to be F6).
3. Numeric keypad — comprises:
   - Number keys with decimal point [.] and change sign [-] keys.
   - Enter — accepts the entered number or confirms a command.
   - Clear — clears the numeric entry field.
   - Measure — places both channels in measure mode.
   - Mode — switches to single display mode and toggles between the two channels when in single display mode.
   - Units — changes between units of measure.
   - Previous — exits the current menu and returns to the previous menu.

4. Rotary Knob — selects a field for editing, and is used for small pressure changes (pressure jog) at the main menu of the single display mode.

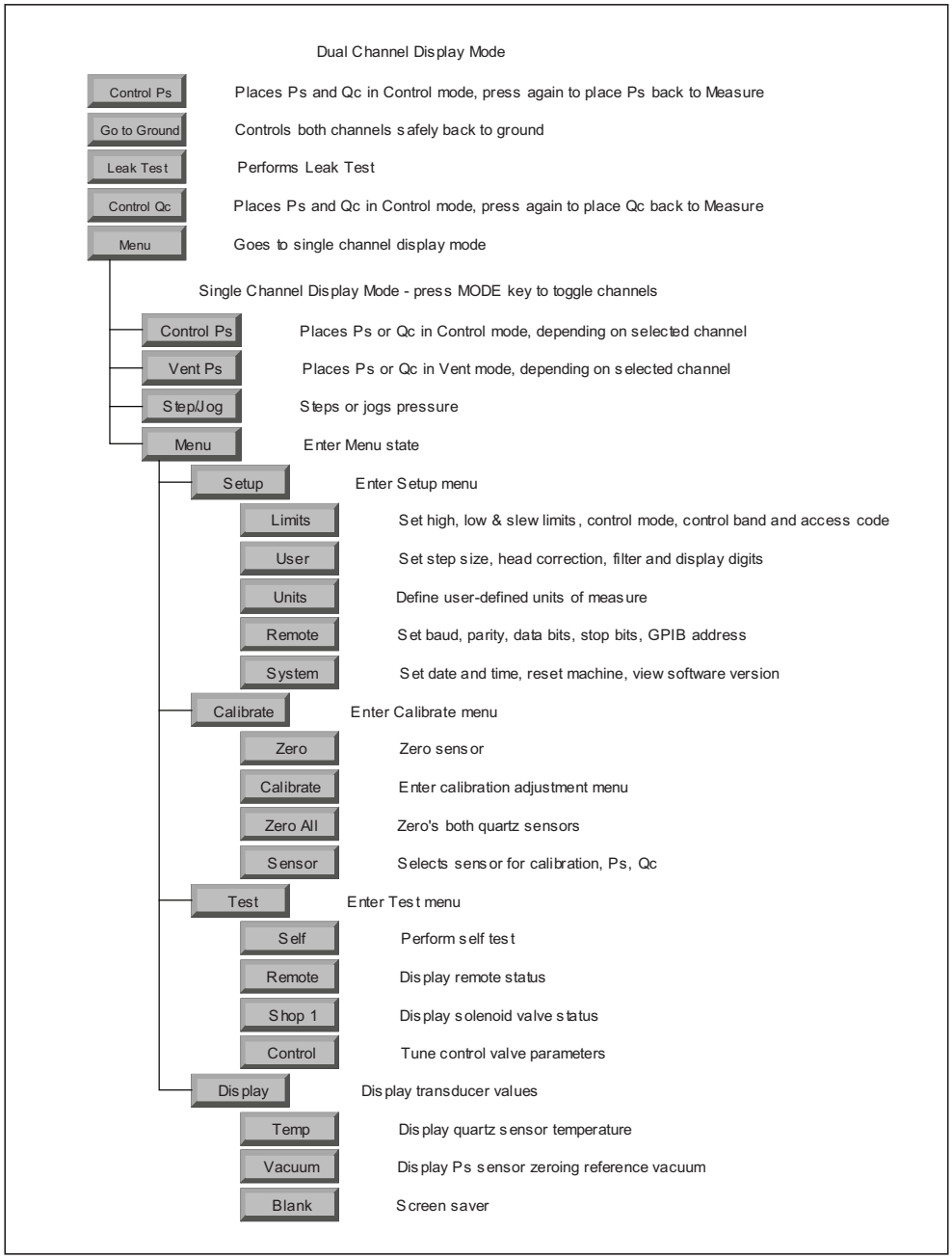

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Figure 4-2. Menu Tree

To move to a lower menu, press the function key with the correct label. To move towards the main menu, press the PREVIOUS key.

Dual Channel Display Screen

The ADTS displays a screen similar to the one shown below at power up. This is the top of the menu tree. The rotary knob may be used to highlight a set point to edit. Then enter the new value using the keypad. This will show up in the scratch pad on the lower portion of the screen. Press the Enter key and the highlighted value will be updated.

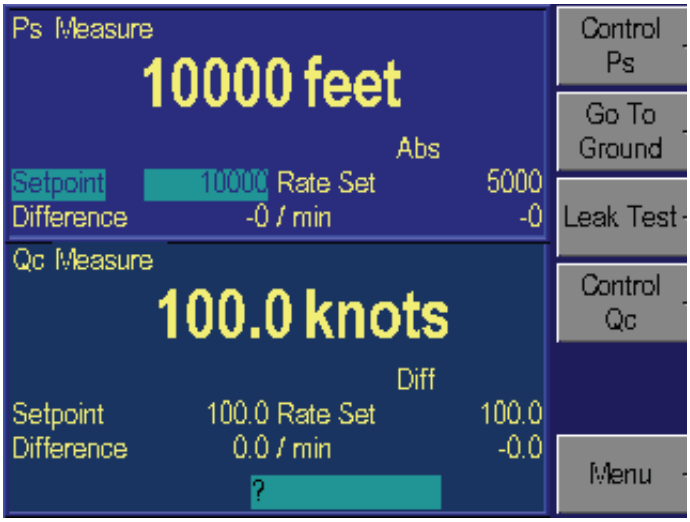

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Figure 4-3. Dual Channel Control Screen

Control Ps and Control Qc

1. Pressing the Control Ps or Control Qc function key places both channels of the ADTS into Control Mode. If only one channel is required in control mode, press either Control Ps or Control Qc function key and that channel will be switched back into the measure mode.
2. Press Enter to confirm the change. The display can be changed such that it only displays a single channel,
3. Press the Menu function key to go to the Ps ONLY CHANNEL screen.
4. Press the Mode key to toggle between Ps ONLY CHANNEL and Qc ONLY CHANNEL screens.

Go to Ground

Go to Ground [F2] function is used to control the pressure in the system to the atmospheric pressure at ground level. Once at ground level, the ADTS physically vents the test port to atmosphere. This allows the operator to return all of the equipment connected to the ADTS back to atmospheric pressure so they can be safely disconnected from the ADTS.

Leak Test

Leak Test [F3] function is used to perform a leak test on the system. This is a timed leak test that allows the operator to enter a wait time and a run time. The operator would control the system to the desired leak test set point. Using the rotary knob, the wait time and the run time can be entered. When initiated, once the wait time has expired, the ADTS would display the current leak rate. This value continuously updates until the run time expires and this displayed value stops updating to document the leak rate over the timed interval.

Single Channel Display Screen

1. Pressing the Menu key from the Main Menu places the unit in a single channel display mode. This mode is generally preferred when operating only a single channel of the ADTS.
2. Press the Mode key to then toggle between the Ps ONLY CHANNEL and the Qc ONLY CHANNEL screens. The ADTS displays the measured pressure in double-sized numbers.

Below the pressure reading is the current unit of measure and mode (Gauge, Differential or Absolute). The RUSKA 7750i is designed such that all of the commonly used functions are accessible by a direct key on the key pad or from a top level function keys. Less commonly used set-up type functions are accessible through the menu function keys.

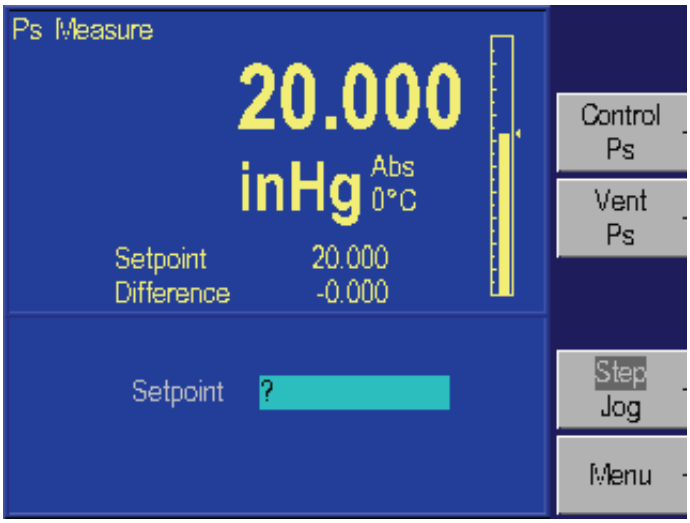

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Figure 4-4. Single Channel Display - Main Menu

Tutorial

To begin the tutorial, first verify that the ADTS is powered-up and that the pneumatic connections have been completed. It is generally easier to first operate the system in the Single Channel Display Screen as opposed to the Dual Screen. Press the Menu function key to go to the Ps Channel screen. Press the Mode key to toggle between the Ps Channel and the Qc Channel screens. Ps Channel is recognizable by the dark blue background color and Qc Channel has a lighter background color. Select Ps Channel to proceed with the tutorial. The ADTS should display a screen similar to the one shown above. (The right hand side of the display shows the options). At power up, there may be errors relating to the default settings. If an error message is displayed in red at the bottom of the screen, press [F6], then press PREVIOUS. If multiple errors exist, the [F6] key must be pressed multiple times to clear all of the errors.

Figure 4-6 shows the Ps Channel Main Menu. The double sized numbers in the top center of the display shows the current measured pressure (20.000 inHg Abs). The upper left corner shows the current mode of the ADTS (MEASURE, CONTROL or VENT). The right side of the screen shows a bar graph displaying the current pressure relative to a user-configurable full-scale value. Below the pressure is the pressure control set point; below this is the difference between the set point and the actual value. Below this is a numeric scratchpad for entering a new set point value. The highlighted label on the right hand side of the screen displays the current assignments of the function keys [F1] through [F6] that are located beside the display.

Changing Units of Measure

1. Change the pressure units. The units are changed by selecting the UNITS key on the keypad.

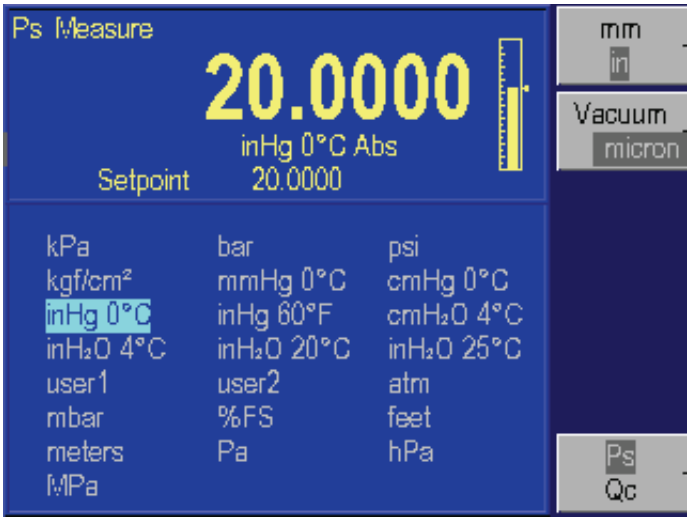

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Figure 4-5. Units - Menu

2. Use the rotary knob located to the right of the display to move the highlight bar to the desired unit.

Note

The highlighted curser initially shows the current unit of measure. When the rotary knob is moved, the current unit remains highlighted in a gray color, and the new unit is highlighted in a light blue color.

3. When the unit desired is highlighted, press the ENTER key on the far right side of the front panel, under the numeric keypad. The display will return to the MAIN screen with the current units.

Note

A different Unit of Measure can be selected for each channel of the ADTS. Select the unit of measure for the Ps channel, and then press the MODE key or the [F6] Function key, toggle to the Qc channel and change its unit of measure.

The second part of this tutorial uses the ADTS to generate pressure. Both pressure and vacuum supplies must be connected and the test port must be connected to a closed volume, in accordance with Chapter 3, Pneumatic Connections, of this manual.

4. From the Main Menu, use the numeric keypad to enter the starting pressure. The pressure is entered in the units set in the previous exercise. As the pressure is entered, each digit will be displayed in the numeric scratchpad (the highlighted box in the lower section of the display). If a mistake is made, press the CLEAR key (found in the numeric keypad), and the numeric scratchpad will be cleared.

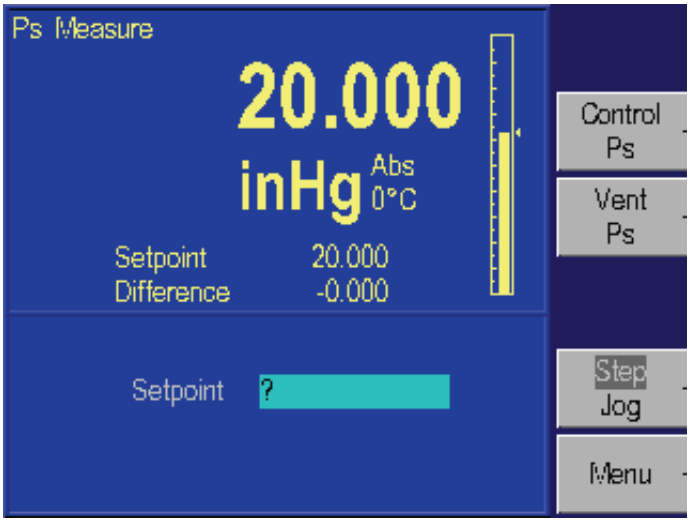

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Figure 4-6. Single Channel Display - Main Menu

5. When the entry is correct, press the ENTER key. The scratchpad will be cleared and the value will appear as the new set point.
6. Now that the starting pressure is entered, enter Control mode. Press Control [F2]. The CONTROL label will be highlight, and the message “Press Enter to Confirm” will appear below the scratch pad. Notice that the upper left corner still shows MEASURE. The ADTS stays in Measure mode until the change is confirmed.
7. Press ENTER to confirm the mode change. The upper left corner will change to CONTROL, and the pressure will start moving towards the set point.
8. After the pressure is stabilized, assure that the word Step is highlighted in the Step/Jog (the [F5] key). The Step/Jog (the [F5] key) toggles between Step and Jog, to switch between these modes, press the function key 5 [F5]. In addition to using the keypad to enter a pressure set point, the step function can also be used. Using the rotary knob, rotate the knob clock-wise to increase the set point, or counter clock-wise to decrease the controller set point. The scratchpad will be updated with a new set point. The step size defaults to 10% of full scale. This step size is user defined and can be changed in the Menu |Menu |Setup |User menu.
9. Press ENTER to accept the new set point. The ADTS will move to the new set point.
10. Press Measure (located on the keypad). The ADTS will change to Measure mode. No confirmation is necessary to leave Control mode.

Selecting Language

The RUSKA 7750i ADTS operates in a variety of different languages. To select a different language, press and hold the MODE key for 5 seconds. The current language will be highlighted. Use the rotary knob to highlight a new language and press the ENTER key to select that language.

Controlling Pressure

Pressing either the Control Ps or Control Qc function key places both channels of the ADTS into the Control Mode. If it is desired to have only one channel in the control mode, press either the Control Ps or Control Qc function key a second time and that channel will be switched back into the measure mode. This will leave only one channel in the control mode. A pressure set point should be entered into the ADTS prior to placing the unit into the control mode. This is to assure that the operator is aware of the set point valve prior to entering into the control mode.

Setting the Pressure Set Point

The pressure set point is the destination of the pressure control algorithm. It should be set before entering Control mode. The pressure set point is set to zero at power-up or whenever a pressure error occurs.

1. The pressure set point can be set from the dual display menu or the Main Menu of the single channel mode. (On the dual channel display mode, use the rotary knob to select which channels set point is being edited.)
2. Use the numeric keypad to enter the new pressure set point in the current pressure units.
3. Press ENTER to accept the entry or press CLEAR to clear the numeric scratchpad.

Note

The set point can also be changed using either the Step or the Jog function. Please see Chapter 4, Step/Jog.

Entering/Exiting Control Mode

1. The Control mode is set from either the dual channel or the single channel display screens. For the Dual channel, press PREVIOUS until the Main Menu appears. For the single channel, press the MENU key and then press the MODE key to toggle between the two different channels.
2. In the dual display mode, pressing either the Control Ps or Control Qc function key places both channels of the ADTS into the Control Mode. If it is desired to have only one channel in the control mode, press either the Control Ps or Control Qc function key a second time and that channel will be switched back into the measure mode. This will leave only one channel in the control mode. ENTER must be pressed to confirm entry into Control mode.

Note

An entry in the numeric scratchpad will also be taken as the new pressure set point. From the single display screen, press the Ps Control [F2] (or Qc Control depending on which channel is operating) to place the selected channel in control mode. ENTER must be pressed to confirm entry into Control mode.

3. Press MEASURE key found in the keypad to exit Control mode. No confirmation is necessary. This will place both channels in the measure mode.

Note

In the dual display mode, if both channels are in control mode, pressing either [F1] or [F4] keys will place only the selected channel into measure mode.

Vent

The Vent [F3] function is used to control pressure in the selected channel to atmosphere. Once at atmospheric pressure, the ADTS physically vents the test port to atmosphere.

Step/Jog

This feature is only available when operating in the single display mode. To place the ADTS in the single display mode from the dual display screen press the MENU key. In addition to entering the pressure set point through the keypad, the pressure set point can be changed using either the step or the jog functions. The Step function is used primarily when the operator is controlling pressure steps in equal pressure increments. The size of the pressure step is user defined. The Jog function is most often used when calibrating mechanical gauges and the operator wishes to change the pressure until the mechanical gauge indicates a cardinal point. The operator can then read the higher resolution ADTS to determine the actual pressure value when the mechanical gauge is indicating a cardinal point. The Step/Jog (the [F5] key) toggles between Step and Jog, to switch between these modes, press the function key 5 [F5].

Stepping

Ensure that the word Step is highlighted in the Step/Jog (the [F5] key). Using the rotary knob, rotate the knob clock-wise to increase the set point, or counter clock-wise to decrease the controller set point. The scratchpad will be updated to a new set point. The step size defaults to 10% of full scale. Press ENTER to accept the new set point.

Setting Step Size

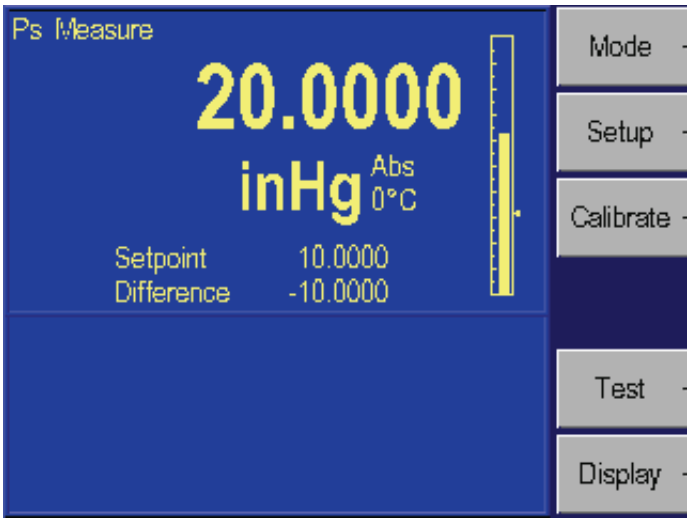
From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6], Menu [F6], Setup [F2], and then User [F2]. Using the rotary knob, move the cursor to highlight Step Size. Enter the desired step size in the current pressure units and press ENTER.

Jogging

Assure that the word Jog is highlighted in the Step/Jog (the [F5] key). From the Single Display Menu, the pressure set point can be modified by rotating the rotary knob clockwise to increase pressure and counterclockwise to decrease pressure. Each increment or decrement will change the pressure in the least significant digit. Continually rotating the rotary knob, the pressure will continue to change until the rotation is stopped.

Menu

The menu key is used to access the less commonly accessed configuration type functions. This accesses the Setup, Calibration, Test and Display functions.



gme14.bmp

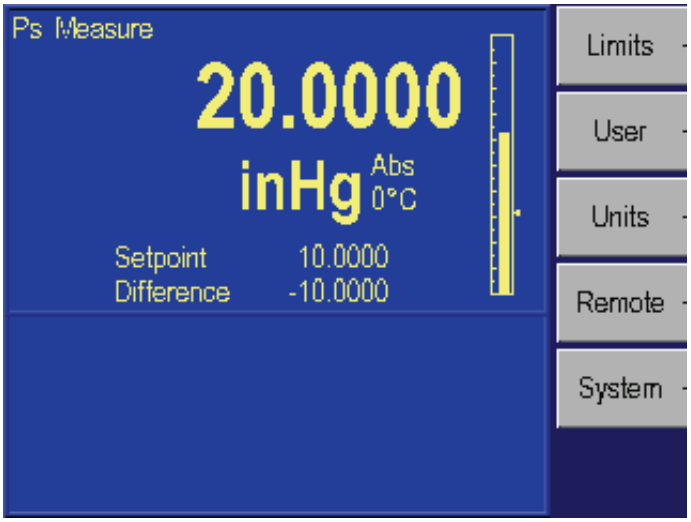
Figure 4-7. Menu | Menu

Menu | Setup

Setup is used to configure the system. It includes setting all of the limits, user parameters, user-defined units of measure, remote interface and system setup. On the RUSKA 7750i, the User and Limits screens are separate for each channel and must be set up independently. The Units, Remote, and System screens are identical in each channel. Any changes made in one channel immediate affects the other channel.

Note

Units of measure are selected for each independent channel. The Setup Units is used to set up the user-defined units of measure.

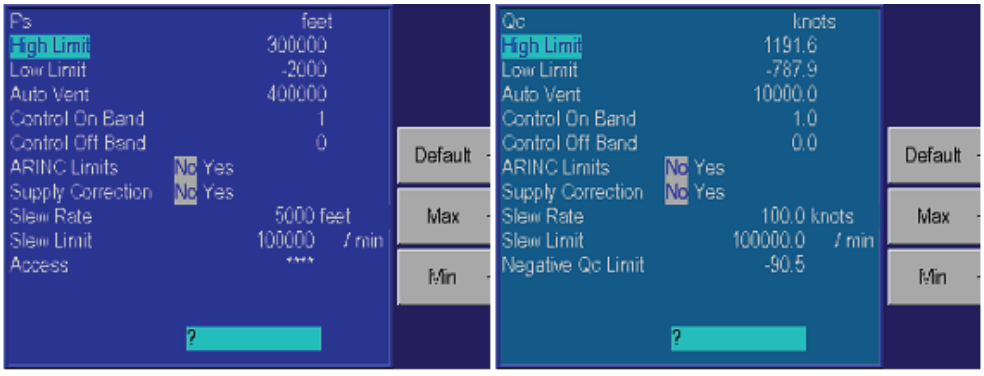


gme15.bmp

Figure 4-8. Menu | Menu | Setup

Menu | Setup — Limits

The Menu | Menu | Setup | Limits menu is used to setup all of the limits in the system. The pressure limits can be used to protect the device-under-test (DUT) from overpressure. All limits are defined separately for each channel. Press the Mode key to switch between two pressure channels. The Access code is common and is used for both channels.



gme16.bmp

Figure 4-9. Menu | Menu | Setup | Limits

High Limit

User defined Maximum pressure limit. This is often set just over the full-scale pressure of the device under test (DUT) in order to protect the DUT. The ADTS will then prevent the pressure from exceeding the high limit. Limits can be set in both engineering and aeronautical units of measure. If the user enters a value greater than the user defined limit, the unit will not accept the value and it will generate an error code informing the user that they have entered a set point that is greater than the high pressure limit. In control mode, if for any reason the pressure exceeds the user defined limit, it will change into the measure mode and again display an error message to the operator informing them of the error that occurred.

This value can be edited using the rotary knob to highlight the High Limit. Then enter the new value using the keypad. This will show up in the scratch pad on the lower portion of the screen. Press the Enter key and the value for the high limit will be updated to the value that was typed into the scratchpad.

Low Limit

User defined Minimum pressure limit. This is the same as the high limit except it is to protect the DUT from low pressure limits.

Auto Vent

User defined maximum pressure that the ADTS can reach prior to venting the test port to atmosphere. The auto vent controls the pressure to atmosphere at then vents the pressure to atmosphere.

Control Band

There are two common pressure control approaches that are available with the RUSKA 7750i ADTS. One of the most common control styles is an Active controller where the controller remains operative and holds the pressure at a commanded set point. This allows the system to hold the pressure at a set point within the control stability specification (See Appendix A). In addition to possible leaks in a system, following a pressure step, the pressure in the system changes due to temperature effects. When operating an Active control system, the controller continuously monitors any pressure variances in the system and compensates for these effects to hold the pressure at the set point. The benefit of the Active control is that it can maintain the pressure at the commanded set point even when there are slight leaks in the system or the system is not thermally stable.

The second approach is to control the pressure in the system to a set point and then to shut-off the Active controller. This is known as Passive control mode. Following a pressure step and the controller becomes passive; the pressure will continue to change in the system due to thermal effects. However these thermal effects will stabilize over time. Once the system has thermally stabilized, pressure measurements can be made in the system without any “pressure noise” injected into the system as a result of having an Active controller in the system. The result would be that the controller would not add any additional uncertainty to the pressure measurement since it would be inactive during the measurement process. For this method, pressure will not be at a cardinal set point.

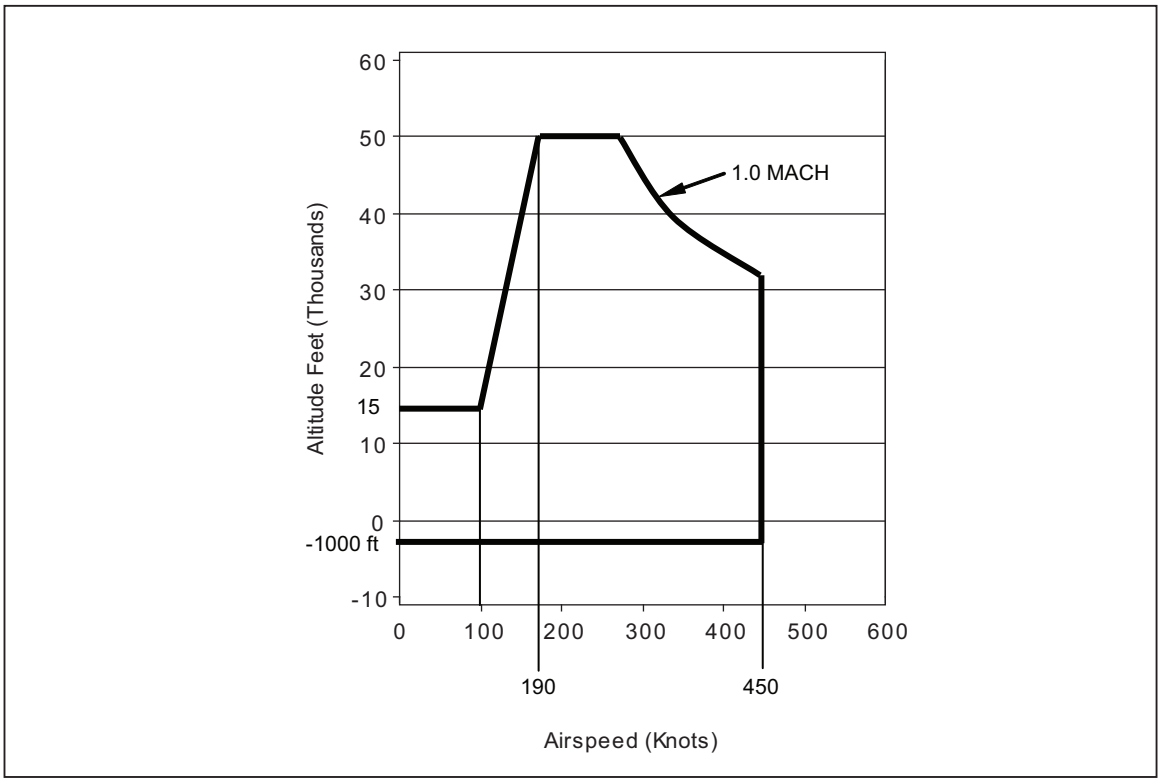
When the Control Off Band is set to zero, the ADTS operates in the Active control mode. Setting a Control On and Off Band, places the ADTS in the Passive control mode. In Passive mode, if the pressure is within the Control Off Band of the pressure set point, the controller is turned off. If the pressure changes to outside the Control Off Band, the controller is turned back on.

ARINC 565 Operating Limits

The ADTS can be set to the ARINC 565 operating limits. When this is selected as YES, the ADTS ignores the user defined minimum and maximum airspeed and altitude limits, and enables the ARINC limits. These limits are defined in the Limits Screen, shown in Figure 4-9.

Supply Correction

If the supply pressure is set at a value less than the value recommended in A-2 of Appendix A, then the control performance may be affected. In this case, the Supply Correction can be set to yes, and the ADTS will adjust its internal control parameters to compensate for the lack of supply pressure. For best performance, it is recommended to supply the ADTS with the full recommended supply pressure and to have the Supply Correction set to no.



gme17.eps

Figure 4-10. Airspeed (Knots)

Slew Rate

User defined maximum pressure rate of change. The ADTS allows the operator to set the rate for both channels of the ADTS.

Slew Limit

The slew limit is used by the system to assure that the slew rate is not exceeded. If the slew rate is exceeded, the ADTS will change from the control mode to the measure mode and it will generate an error message to the operator.

Negative Qc Limit

The Negative Qc limit is the maximum allowable negative differential pressure (and negative airspeed) allowed. When in control mode and this limit is exceeded, the ADTS will change from the control mode to the measure mode and it will generate an error message to the operator. This limit only exists in the Qc limit screen. Press MODE key to toggle between the Ps and the Qc channels.

Access

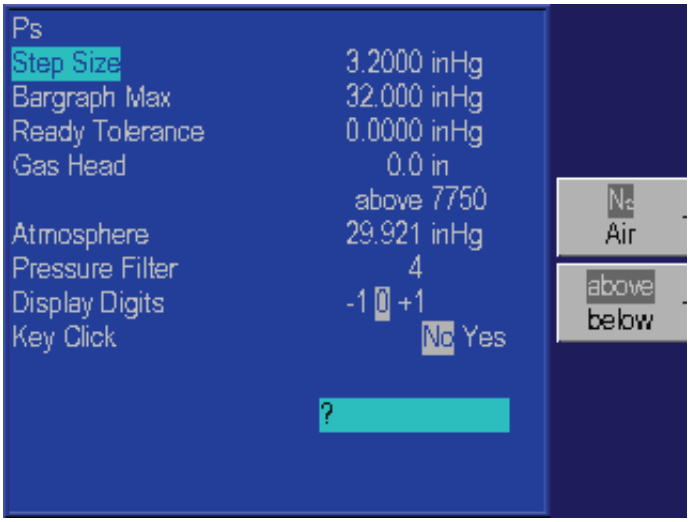
The test access password allows the user to protect access to ADTS configuration and programs. If the test access password is set to any number other than zero (factory default), it is required before the user is allowed to change the limits, control parameters or programs. The access key is only shown on the Ps channel. Press MODE key to toggle between the Ps and the Qc channels.

Note

It is recommended that the access password be recorded and filed in a secure location.

Menu | Setup — User

The Menu | Menu | Setup | User menu is used to setup all of the user specific configurations. This includes setting the control step size, range of bar-graph, pressure gas head, display pressure filter, display resolution digits, and audible key click. The step size, bar-graph max, ready tolerance and gas head are defined separately for each channel. All other entries are common for both channels. Press MODE key to toggle between the Ps and the Qc channels.



gme18.bmp

Figure 4-11. Menu | Menu | Setup | User

Step Size

In addition to entering the pressure set point by the key-pad, the pressure set point can be changed using the step function. The step function is used primarily when the operator is taking pressure steps in equal pressure increments. The size of the pressure step is user defined. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6], Menu [F6], Setup [F2], and then User [F2]. Using the rotary knob, move the cursor to highlight Step Size. Enter the desired step size in the current pressure units and press ENTER.

Bar Graph Maximum

The bar graph on the Main Menu screen can be scaled to match the device under test by setting the full scale value of the bar graph.

Ready Tolerance

A Ready indication is generated when in control mode and the measured pressure is reading within this ready tolerance value. When running an internal program, the ready indicator is shown when the measured pressure is within the tolerance stored in the program. It is recommended that the Ready tolerance be set to a value greater than the Control Stability Specification defined in Appendix A.

Gas Head Pressure Correction

The term “head height” refers to the vertical distance between the sensing element in the device under test and the ADTS’s pressure reference plane. Once the user inputs the head height and selects air or nitrogen, the ADTS automatically corrects for head pressure.

1. The Pressure Reference Line on the ADTS is defined as the bottom of the color display where the display and the front panel join. This provides the reference plane against which the device under test (DUT) pressure is measured. Determine the vertical distance between the ADTS Pressure Reference Line and the reference plane of the device under test.
2. Press the Unit key found in the keypad and press in/mm [F1] to select either inches (in) or millimeters (mm) for the head height entry.
3. The head height is set from the Menu | Menu |Setup | User. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6], press Menu [F6], then Setup [F2], and then User [F2].
4. Press Medium [F3] to select either “Air” or “Nitrogen.” The selected units will be highlighted.
5. Press Position [F4] to select if the position of the Device Under Test is either “Above” or “Below” the RUSKA 7750i. The selected units will be highlighted and appear in the Gas Head description.
6. Use the rotary knob to highlight the label “Gas Head.”
7. Use the numeric keypad to enter the height in the selected unit.
8. Press ENTER to accept the entry.

Atmosphere

The nominal barometric pressure value for the location that the ADTS is utilized should be entered for atmosphere. This number is used to calculate the density of the test port pressure medium and to correct for head pressure variances between the reference port of the ADTS and the DUT.

Pressure Filter

Pressure Filter is used to adjust the degree to which the front display pressure value is filtered. A value of four (4), is the default value. As the value increases, the filtering level increases, however, the display update rate reduces. Typical filter values would range between 1 to 10. For pressure sensors with full scale ranges of 1 psi (7 kPa) or less, a filter value up to 30 is typically recommended.

Changing the Number of Decimals

Each unit has a default number of decimal places used for pressure display. This may be adjusted up or down by one decimal place.

1. The decimal digits are set from the Menu | Menu |Setup | User. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6], Menu [F6], then Setup [F2], and then User [F2]. Press the MODE key to toggle between the Ps and the Qc channels.
2. Turn the rotary knob until the label “Display digits” is highlighted.
3. Turn the rotary knob further until the desired number of digits from the default resolution is highlighted (-1, 0, +1), and then press the ENTER key to select.

Key Click

The ADTS can be configured to emit a “clicking” sound each time a key is pressed.

1. The key “click” is set from the Menu | Menu |Setup | User. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6], Menu [F6], then Setup [F2], and then User [F2].
2. Turn the rotary knob to highlight “Key click” and then highlight either on or off.
3. Press the ENTER key to select.

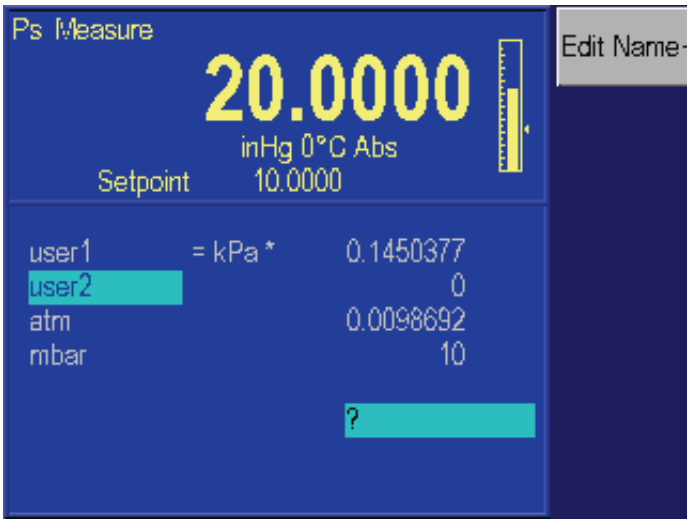
Menu | Setup — Units

In addition to the standard units of measure provided by the ADTS, two user-defined units are available. To create a user-defined unit, the user enters a name that is one to ten characters long and a conversion factor that is a multiple of kiloPascals (kPa).

For example, using the information from Table 2-1, the conversion factor for millitorr or one micron of mercury at 0 °C is calculated as follows:

$$mTorr = kPa\ x\ \frac{1000\,mTorr}{1\,Torr}\ x\ \frac{1\,Torr}{1\,mmHg0^{oC}}\ x\ \frac{1\,mm\,Hg\,0^{o}}{0.0193377\,psi}\ x\ \frac{0.1450377\,psi}{1\,kPa}$$

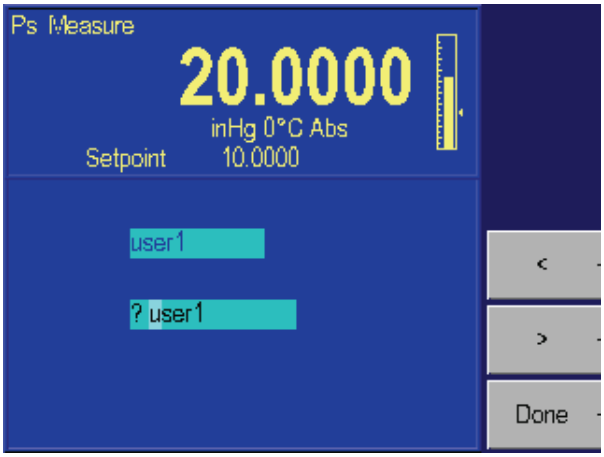
Thus the conversion factor simplifies to $mTorr = kPa\ x\ 7500.6180$



gme19.bmp

Figure 4-12. Menu | Menu | Setup | Units

1. The pressure units are defined from the Menu | Menu| Setup | Units. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6], Menu [F6], then Setup [F2], then Units [F3].
2. Use the rotary knob to highlight the desired user-defined unit, and then select the Edit Name [F1] function key.
3. The following sequence is used to change the name of the selected unit.
   a. Use the < [F4] or > [F5] key to highlight the desired character in the matrix.
   b. Use the rotary knob to change the character.
   c. Repeat steps a and b until the desired name is entered. Press the Clear key to start over.
   d. Press the Done [F6] key when the name change is completed.



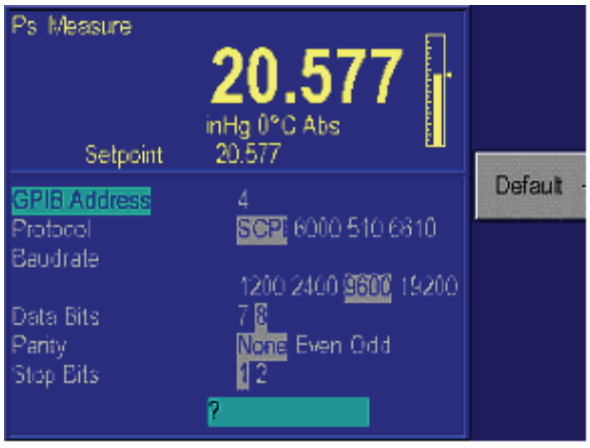
gme20.bmp

Figure 4-13. Menu | Menu | Setup | Units | Edit Name

4. Use the rotary knob to highlight the desired user-defined unit that has just been renamed.
5. Use the numeric keypad to enter the conversion factor and press ENTER to accept.
6. Press PREVIOUS three times to return to the Main Menu. The new unit definition may now be selected using the Units key.

Menu | Setup — Remote

The Menu | Setup | Remote screen is where the remote communication interface is set-up.



gme21.bmp

Figure 4-14. Menu | Menu | Setup | Remote

GPIB Address

Sets the IEEE-488 interface address.

Protocol

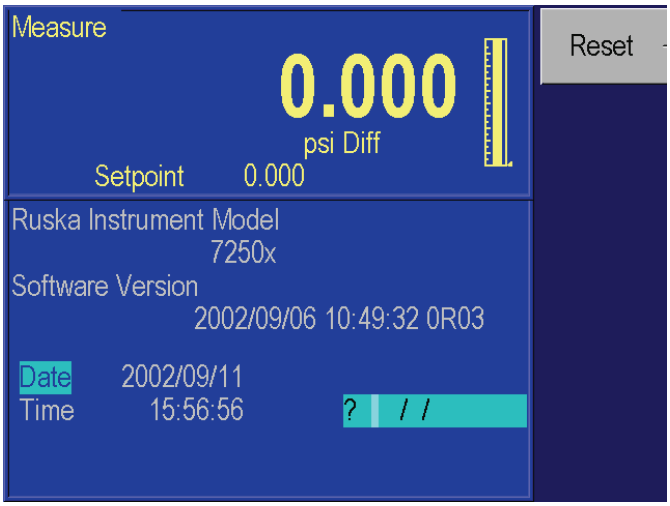
The Protocol defines which protocol should be used by the remote interface. The options are Standard Communication for Programmable Instruments (SCPI) and RUSKA 6610 emulation.

Serial Interface Set-Up

The operator can set-up the Baud Rate, Data Bits, Parity, and Stop Bits for the Serial Interface.

Menu | Setup — System

The System Menu identifies the Software release version that is being operated in the ADTS. It also stores and allows the operator to edit the Date and Time.



gme22.bmp

Figure 4-15. Menu | Menu | Setup | System

Date/Time

The ADTS's system clock is continuously updated. If the date or time requires editing, the following applies;

1. The date and time are set from the Menu | Menu | Setup | System. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6], Menu [F6], then Setup [F2], and then System [F5].
2. To set the system date, turn the rotary knob until Date is highlighted. Use the numeric keypad to enter the current four-digit year, month, and day (yyyymmdd). All digits must be entered. Press ENTER to accept.
3. To set the system time, turn the rotary knob until Time is highlighted. Use the numeric keypad to enter the current hour, minute, and second (hhmmss). All digits must be entered. Press ENTER to accept.

Reset

The Reset [F1] command is used to re-boot the ADTS.

To reset the system, from the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6], Menu [F6], then Setup [F2], then System [F5], and then Reset [F1].

Menu | Calibrate

The Menu | Calibrate command is used to perform the calibrations on all of the sensors utilized by the ADTS. The RUSKA 7750i can be completely calibrated using the front panel interface. It does not require any external computer or software in order to perform a successful calibration. It also has the capability of being calibrated remotely through either the RS232 or IEEE-488 interface. The RUSKA 7750i will guide the operator through a menu driven calibration procedure identifying the pressures that should be supplied by a standard. Following the calibration procedure, the RUSKA 7750i calculates and saves its own coefficients. The calibration coefficients are date stamped so the user can easily identify the last time the instrument went through a full calibration, when the coefficients were last edited or when the ADTS was re-zeroed.

The calibration section in the ADTS can be password protected to prevent any unauthorized entry into the calibration section of the system. Please refer to Chapter 6, Maintenance, of the manual for more detailed information regarding the calibration of the ADTS. The calibration menu is identical in both channels. Press the Sensor function key to select the correct sensor from either channel.

Calibration Password

The calibration password allows the user to protect access to ADTS calibration constants and the calibration procedure. If the calibration password is set to any number other than zero, it is required before the user is allowed to calibrate the ADTS or manually change the calibration constants.

Note

It is recommended that the access password be recorded and filed in a secure location.

1. The calibration password is set from the Calibration Menu. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6], Menu [F6], then Calibrate [F3].
2. Press the Access [F4] key. If there is a password in the system other than 0, then the current valid password must be entered into the RUSKA 7750i before password modification will be allowed.
3. Use the numeric keypad to enter the new calibration password. Setting the calibration password to zero allows free access to ADTS calibration and constants. Press ENTER.
4. Press Yes [F4] to acknowledge changing the calibration password. Press No [F5] to reject changing the calibration password.

Zeroing

The ADTS should be zeroed once a day to maintain optimal performance. The zero drift specification is defined in Appendix A, under General Specifications. Refer to Chapter 6, Zeroing, for the zeroing procedure. On the differential Qc sensor, the zeroing procedure automatically ties both test and reference ports of the quartz sensor together and performs the zeroing routine.

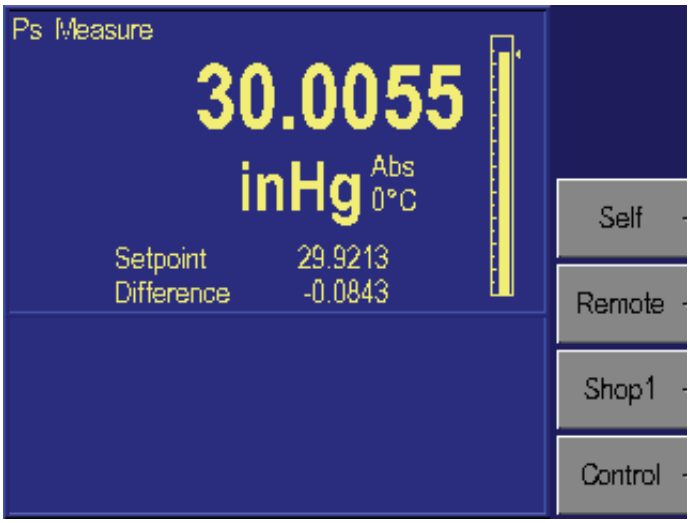
On the permanent absolute Ps sensor, a high capacity vacuum pump is required to zero the instrument. A vacuum gauge sensor is installed internally to the Ps sensor very near to the quartz sensor. The zeroing command will cycle the internal valves allowing the external vacuum pump to pull a hard vacuum on the quartz sensor. The sensor should be pulled down to a vacuum of less than 100 mtorr in order to obtain a proper zero. Note, for the highest measurement performance, it is recommended to zero the RUSKA 7750i at a vacuum level of 60 mtorr or less. This is typically achievable within 30 minutes; however, in high humidity situations the drying time can extend to 45 minutes. It is also important that the vacuum level be stable to at least 5 mtorr per minute. Once the vacuum level is stable, the user initiates the zeroing procedure. Please refer to

Chapter 6, Maintenance, of the manual for more detailed information regarding the zeroing procedure of the ADTS.

The ADTS can be zeroed at higher vacuum levels, however, the uncertainty of vacuum sensors tend to increase at higher vacuum levels, therefore, the uncertainty in the ADTS would also increase if zeroed at higher vacuum levels.

Menu | Test

The Menu | Test section of the system is used to perform a number of the diagnostic and tuning functions that are available with the RUSKA 7750i. The Sweep and Control test operate on the current selected channel. The other screens are independent of the selected channel.



gme23.bmp

Figure 4-16. Menu | Menu | Test

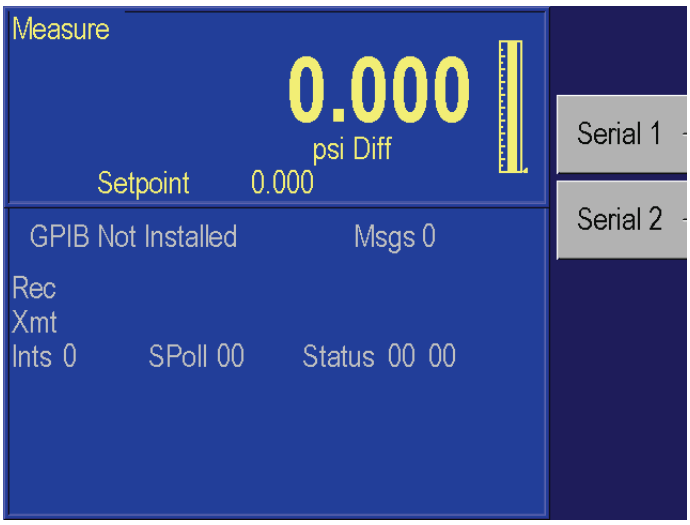
Menu | Test — Self Test

The ADTS can perform electrical and pneumatic self-test to assist in trouble shooting potential problems. Please refer to Chapter 6, Maintenance, for more details.

Menu | Test — Remote Test

The Menu | Menu | Test | Remote section of the system is used to perform a number of the diagnostic functions on the remote interface. It can be used to display the transmitted and received messages that are sent across the interface. This can be a powerful tool to assist in identifying the source of communication problems.

The Menu | Menu| Test | Remote menu displays information from the IEEE-488 interface. Pressing the Serial 1 [F2] or Serial 2 [F3] keys will display information from the serial ports.

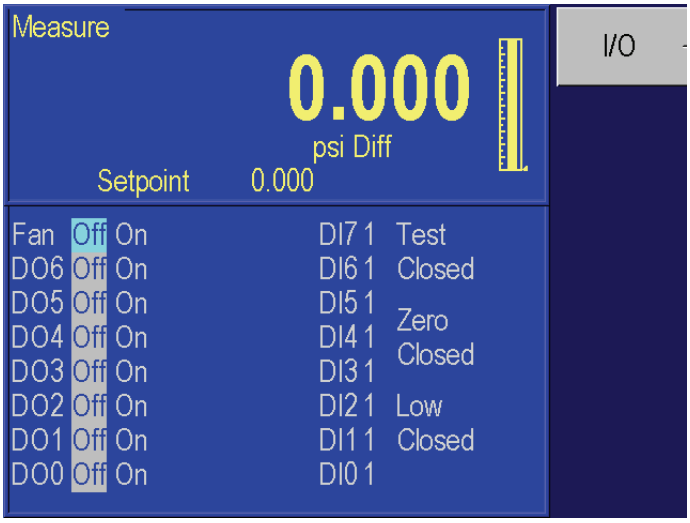


gme24.bmp

Figure 4-17. Menu | Menu | Test | Remote - GPIB

Menu | Test — Shop1

The Menu | Menu | Test | Shop1 menu of the system is used to display the current status of the various valve positions in the system. This menu is primarily used for diagnostics and will be discussed further in Chapter 6, Maintenance.

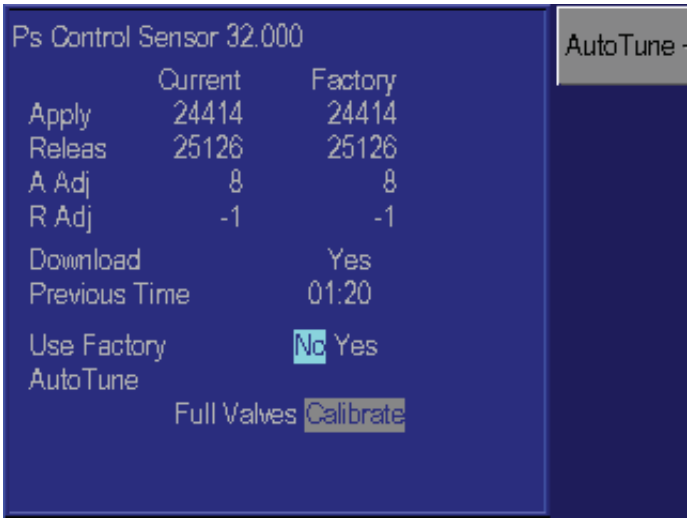


gme25.bmp

Figure 4-18. Menu | Menu | Test | Shop1

Menu | Test — Control

The Menu | Menu | Test | Control menu of the system is used to tune the controller. On new instruments, the controller is tuned at the factory and therefore, the user should not need to access or make any adjustments to the controller using this menu. This menu is user accessible in order to provide a means to set-up the controller when control valves are replaced or to perform maintenance on the controller. The menu is primarily used for diagnostics and repair, shown in Figure 4-19, and will be discussed further in Chapter 6, Maintenance.

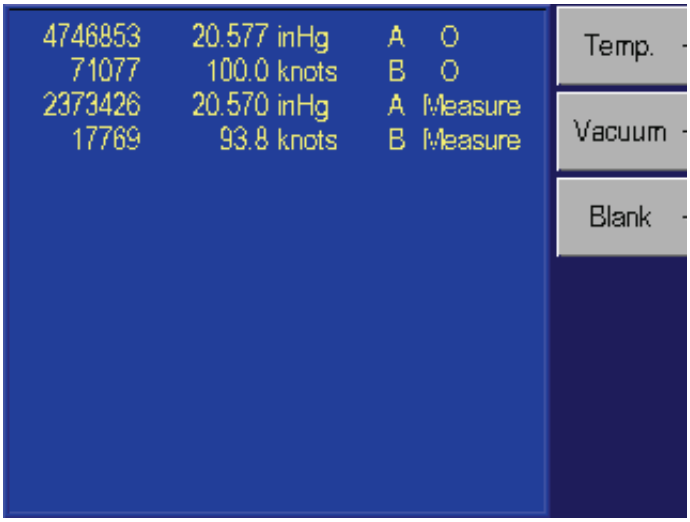


gme26.bmp

Figure 4-19. Menu | Menu | Test | Controller

Menu | Display

The Menu | Menu | Display is used to conveniently monitor most of the sensor output parameters. It is primarily used for troubleshooting. This display screen shows all available sensor readings from both channels.



gme27.bmp

Figure 4-20. Menu | Menu | Display

Menu | Display — Temperature

This displays the current temperature of each sensor and the oven control duty cycle.

Menu | Display — Vacuum

This displays the current reading from the vacuum sensor that is used to zero the Ps sensor. When railed to a high value, it indicates 350 mtorr. When the vacuum level present in the Ps sensor is less than 350 mtorr, this sensor indicates the actual vacuum level.

Menu | Display — Blank

This is used as a screen saver in the RUSKA 7750i.

Chapter 5
Remote Operation

Capabilities

The ADTS can be operated remotely by a computer. Two interfaces are supported: IEEE-488 and RS-232. Both interfaces support SCPI (Standard Commands for Programmable Instruments). The IEEE-488 interface additionally supports emulation of a RUSKA 6610 ADTS. The IEEE-488 interface conforms to the following standards:

ANSI/IEEE Std 488.1-1987	IEEE Standard Digital Interface for Programmable Instrumentation
ANSI/IEEE Std 488.2-1987	IEEE Standard Codes, Formats, Protocols, and Common Commands
SCPI 1991.0	Standard Commands for Programmable Instruments

IEEE-488

The following identification codes define the interface capabilities of the ADTS. Identification codes are described in the IEEE-488 standard.

SH1	Source Handshake, Complete Capability
AH1	Acceptor Handshake, Complete Capability
T5	Talker
L3	Listener
SR1	Service Request, Complete Capability
RL1	Remote-Local, Complete Capability
PP0	Parallel Poll, No Capability
DC1	Device Clear, Complete Capability
DT0	Device Trigger, No Capability
C0	Controller, No Capability

The IEEE-488 interface is installed next to the processor board. The interface is identified by the IEEE-488 standard connector on the back panel of the unit.

Note

Do not change any jumpers or switch settings on the IEEE-488 interface board. The IEEE-488 address is set by the MENU / SETUP / REMOTE screen.

RS-232

The RS-232 interface supports standard serial operation from a computer to a single ADTS. RS-232 supports the IEEE-488.2 and SCPI commands. The ADTS allows the following port setups:

Baud Rate:	1200, 2400, 9600, or 19200
Data Bits:	7 or 8
Parity:	Even, Odd, or None
Stop Bits	1 or 2
Handshaking	XON/XOFF

The RS-232 connection is a DB-9P connector found on the back panel of the ADTS. It is located on the processor board. The following pins are used; all other pins are reserved.

Pin #	Direction	Signal
2	In	RXD Receive Data
3	Out	TXD Transmit Data
5	——	GND Ground
7	Out	RTS Request to Send

Remote/Local Operation

In Local mode, the ADTS is operated manually through the front panel. Chapter 4 covers local operation. The ADTS always powers up in the Local mode. In Remote mode, the ADTS is operated by a computer connected to an interface. Most functions that can be performed in Local mode can also be performed remotely. Remote mode does not automatically disable local operation. The remote interface may be active while local operations are being done. In cases where full remote control is required, the following methods may be used.

1. Issue a Local Lockout (LLO) interface message via the IEEE-488 interface. The ADTS will disable the local keyboard until the Go To Local (GTL) interface message is received or the REN (Remote Enable) line is unasserted. This method cannot be used on the serial interface.
2. Issue the SCPI command “SYSTEM:KLOCK ON” to lock the local keyboard. The ADTS will disable the local keyboard until the command “SYSTEM:KLOCK OFF” is received.
3. Issue the SCPI command “DISPLAY:ENABLE OFF” or “DISPLAY:TEXT <string>.” These commands will disable the local display in addition to locking the keyboard. The command “DISPLAY:ENABLE ON” will restore the local display and keyboard operation.

Local operation may also be restored by turning the ADTS off and back on.

Configuration

The remote interface must be configured before it is connected. The remote interface is configured using the local interface. The parameters needed vary with the interface used.

IEEE-488	Address, Protocol
RS-232	Baud Rate, Data Bits, Parity, Stop Bits

To configure the remote interface:

1. The remote interface is configured from the Setup | Remote | Menu. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6], then Setup [F2], and finally Remote [F4].
2. Use the rotary knob to highlight the desired parameter.
3. Use the numeric keypad to enter the address; use the rotary knob to change the other parameters. The ENTER key must be pressed after entering the address.
4. Repeat steps 2 and 3 to set all parameters needed.

Device Messages

SCPI Command Format

SCPI mnemonics have two forms: long and short. The short form is all in capital letters. The long form is the entire mnemonic. Commands may use either the short form or the entire long form. No other forms are accepted. SCPI ignores case: uppercase and lowercase are equivalent.

A SCPI command is made by following the command tree as presented in the command summary. Each level adds a mnemonic to the command separated by colons (:). Mnemonics enclosed in square brackets are optional and may be omitted.

Some mnemonics are followed by an optional numeric suffix. If omitted, the suffix defaults to 1.

Multiple commands may be placed in a single message separated by semicolons (;). Each command starts at the same level of tree where the last command stopped, unless the command starts with a colon. The first command in a message and any commands starting with a colon start at the root of the command tree. IEEE 488.2 commands may occur between SCPI commands without affecting the tree level.

Command parameters are separated from the command name by one or more spaces. Multiple parameters are separated by commas (,). SCPI accepts numeric parameters with optional sign, decimal point, and exponent. OFF is equivalent to zero and ON is equivalent to one. Floating point numbers are rounded to the nearest integer for commands accepting integer values only.

A message is terminated by a line feed (hexadecimal 0A). Carriage returns, tabs, and other control characters are ignored.

SCPI Response Format

Most values can be queried by appending a question mark (?) to a command and not specifying any parameters. Commands ending with a question mark (?) in the command summary cannot be set only queried. Multiple values from a single command are separated by commas. Responses from different commands in the same message are separated by semicolons (;). The response message is terminated by a line feed (hexadecimal 0A).

Integer responses are returned as one or more digits. Boolean values (ON and OFF values) are always returned as numbers, with zero for OFF and one for ON. Floating point values are returned in the format “+d.ddddddddE+dd.”

ANSI/IEEE 488.2-1987 Command Summary

*CLS	Clear Status
*ESE?	Event Status Enable Query
*ESE <number>	Event Status Enable
*ESR?	Event Status Register
*IDN?	Identification
*OPC?	Operation Complete Query (Returns 1)
*OPC	Operation Complete
*RST	Reset
*SRE?	Service Request Enable Query
*SRE <number>	Service Request Enable
*STB?	Status Byte Query
*TST?	Self-Test Query
*WAI	Wait (No operation)

SCPI Command Summary

The current value associated with a SCPI command may be read by appending a question mark to the command. For example CALC:LIM:UPP? will return the current upper pressure limit.

```
MEASure
[:PRESsure]?                        Ps Channel Pressure
[:PRESsure]11?                      Qc Channel Pressure
[:PRESsure]4?                       Ps Control Sensor
[:PRESsure]14?                      Qc Control Sensor
[:PRESsure]? ALT                    Altitude**
[:PRESsure]? CAS                    Airspeed**
[:PRESsure]? MACH                   Mach
[:PRESsure]? PS                     Ps Pressure
[:PRESsure]? QC                     Qc Pressure
[:PRESsure]? PT                     Pt Pressure
:RATE? ALT                          Altitude instant rate**
:RATE? CAS                          Airspeed instant rate**
:RATE? MACH                         Mach instant rate
:RATE? PS                           Ps instant rate
:RATE? QC                           Qc instant rate
:RATE? PT                           Pt instant rate
:TEMPerature2?                      Ps Sensor Temperature
:TEMPerature12?                     Qc Sensor Temperature
:TRATE? ALT                         Altitude timed rate**
:TRATE? CAS                         Airspeed timed rate**
:TRATE? MACH                        Mach timed rate
:TRATE? PS                          Ps timed rate
:TRATE? QC                          Qc timed rate
:TRATE? PT                          Pt timed rate
:VACuum?                            Ps Vacuum

CALCulate
[:PRESsure]
   :TARE
       :VALue <number>                Tare Ps Sensor
       :STATe ON|OFF                  Tare State
   :LIMit
       :LOWer <number>                Ps low pressure limit
       :SLEW <number>                 Ps slew rate limit
       :UPPer <number>                Ps high pressure limit
       :VENT <number>                 Ps auto-vent limit
:PRESsure11
   :LIMit
       :LOWer <number>                Qc low pressure limit
       :SLEW <number>                 Qc slew rate limit
       :UPPer <number>                Qc high pressure limit
       :VENT <number>                 Qc auto-vent limit
```

```
  :LIMit
      :MAXimum
           :PRESsure ALT,<number>       Maximum Altitude limit**
           :PRESsure CAS,<number>       Maximum Airspeed limit**
           :PRESsure MACH,<number>      Maximum Mach limit
           :PRESsure PS,<number>        Maximum Ps pressure limit
           :PRESsure QC,<number>        Maximum Qc pressure limit
           :PRESsure PT,<number>        Maximum Pt pressure limit
           :RATE ALT,<number>           Maximum Altitude rate limit**
           :RATE CAS,<number>           Maximum Airspeed rate limit**
           :RATE MACH,<number>          Maximum Mach rate limit
           :RATE PS,<number>            Maximum Ps Pressure rate limit
           :RATE QC,<number>            Maximum Qc Pressure rate limit
           :RATE PT,<number>            Maximum Pt Pressure rate limit
      :MINimum
           :PRESsure ALT,<number>       Minimum Altitude limit**
           :PRESsure CAS,<number>       Minimum Airspeed limit**
           :PRESsure MACH,<number>      Minimum Mach limit
           :PRESsure PS,<number>        Minimum Ps pressure limit
           :PRESsure QC,<number>        Minimum Qc pressure limit
           :PRESsure PT,<number>        Minimum Pt pressure limit

CALibration
      :MODE?                            Calibration enabled?
      :MODE <number>                    Request calibration mode (access code
      :DRY
           :ABORt                       Ps Abort dry mode
           :INITiate                    Ps Initiate dry mode

:PRESsure
      :ZERO
           :ALL
            :VACuum <number>            Set maximum vacuum (UNIT:VAC)
            :INITiate                   Start Ps and Qc zero
            :STOP                       abort zero calibration
            :WAIT <minutes>,<seconds>   Set minimum zero wait time

:PRESsure
      :VALue<n><number>                perform Ps calibration point
      :DATA
           :POINts?                    number of Ps calibration constants
           :VALue<n>?                  label,value(C0,0.123)
           :VALue<n><number>           Set calibration constant
      :CALibration
           :VALue<n>?                  Ps nominal calibration point
           :POINts?                    Ps number of calibration points
      :DATE?                           Ps last calibration date
      :TIME?                           Ps last calibration time
      :ZERO
           :DATE?                      Ps last zero date
           :TIME?                      Ps last zero time
           :VALue <number>             Ps sets vacuum value (UNIT:VAC)
           :VACuum <number>            Ps set maximum vacuum (UNIT:VAC)
           :INITiate                   Ps enter zero mode
           :INITiate?                  Ps status for cal, press, temp, ref
           :RUN                        Ps start zero calibration
           :STOP                       abort zero calibration
           :WAIT <minutes>,<seconds>   Set minimum zero wait time

:PRESsure11
      :VALue<n> <number>               perform Qc calibration point
      :DATA
           :POINts?                    number of Qc calibration constants
           :VALue<n>?                  label,value  (C0,0.123)
           :VALue<n> <number>          Set calibration constant
      :CALibration
           :VALue<n>?                  Qc nominal calibration point
           :POINts?                    Qc number of calibration points
      :DATE?                           Qc last calibration date
```

```
      :TIME?                          Qc last calibration time
      :ZERO
           :DATE?                     Qc last zero date
           :TIME?                     Qc last zero time
           :INITiate                  Qc enter zero mode
           :INITiate?                 Qc status for cal, press, temp, ref
           :RUN                       Qc start zero calibration
           :STOP                      abort zero calibration

PRESsure4  Ps Control Sensor
      :VALue<n> <number>              perform calibration point
      :DATA
           :POINts?                   number of calibration constants
           :VALue<n>?                 label,value  (C0,0.123)
           :VALue<n> <number>         set calibration constant
      :CALibration
           :VALue<n>?                 nominal calibration point
           :POINts?                   number of calibration points
      :ZERO <number>                  Zero sensor

PRESsure14 Qc Control Sensor
           Same as PRESsure4 above
      VACuum                          Ps Vacuum
           Same as PRESsure4 above
      VACuum11                        Qc Vacuum
           Same as PRESsure4 above
      TEMPerature2                    Ps Sensor Temperature
           Same as PRESsure4 above
      TEMPerature12                   Qc Sensor Temperature
           Same as PRESsure4 above
DISPlay
      :ENABle ON|OFF|1|0              turns front panel display on/off
      :TEXT "<text>"                  display message on front panel
      [:PRESsure]
           :BGRaph <number>           set Ps bar graph maximum
      :PRESsure11
           :BGRaph <number>           set Qc bar graph maximum
OUTPut
      [:PRESsure]
           :MODE MEASure|CONTrol|VENT Ps mode
           :STATe ON|OFF|1|0          Ps off=MEASure, on=CONTrol
      :PRESsure11
           :MODE MEASure|CONTrol|VENT Qc mode
           :STATe ON|OFF|1|0          Qc off=MEASure, on=CONTrol
SENSe
      [:PRESSure]
           :RANGE
                :UPPer]?              Ps Full scale value in units
                                      (calibrated)
                :LOWer?               Ps Low cal point
           :REFerence
                [:HEIGht] <number>    Ps gas head height
                :MEDium N2|AIR        Ps gas head medium
           [:RESolution] <number>     Ps Pressure display resolution
                :AUTO ONCE            Returns to default resolution
      :PRESSure11
           :RANGE
           [:UPPer]?                  Qc Full scale value in units
                                      (calibrated)
           :LOWer?                    Qc Low cal point
      :REFerence
           [:HEIGht] <number>         Qc gas head height
           :MEDium N2|AIR             Qc gas head medium
      [:RESolution] <number>          Qc Pressure display resolution
           :AUTO ONCE                 Returns to default resolution
      :TRATe?                         OFF|WAITING|TIMING|TIMED
           :RESet                     Cancel rate timing
           :STARt                     Start rate timing
           :TIME <minutes>,<seconds>  Time Period for rate timing
           :WAIT <minutes>,<seconds>  Wait Period for rate timing
```

```
[SOURce]
      :GTGRound                          Go to ground
      :GTGRound?                         Returns 1 if safe at ground
      :LIMit
           :ARINc ON|OFF|1|0             ARINC limit checking
           :AIRCraft STANDARD|MAX|ARINC
           :MACH ON|OFF|1|0              Mach limit disable
      :PRESsure ALT,<number>             Altitude Setpoint**
      :PRESsure CAS,<number>             Airspeed setpoint**
      :PRESsure MACH,<number>            Mach Setpoint
      :PRESsure PS,<number>              Ps Pressure setpoint
      :PRESsure PT,<number>              Pt Pressure setpoint
      :PRESsure QC,<number>              Qc Pressure setpoint
      [:PRESsure] <number>               Ps pressure control setpoint
           :CONTrol
                :OFF <number>            Ps Control Off band
                :ON <number>             Ps Control On band
           :SLEW <number>                Ps slew rate
           :TOLerance <number>           Ps output tolerance
      :PRESsure11 <number>               Qc pressure control setpoint
           :CONTrol
                :OFF <number>            Qc Control Off band
                :ON <number>             Qc Control On band
           :SLEW <number>                Qc slew rate
           :TOLerance <number>           Qc output tolerance
      :RATE ALT,<number>                 Altitude rate setpoint**
      :RATE CAS,<number>                 Airspeed rate setpoint**
      :RATE PS,<number>                  Ps rate setpoint
      :RATE PT,<number>                  Pt rate setpoint
      :RATE QC,<number>                  Qc rate setpoint
STATus
   :OPERation
      [:EVENT]?                          read/clear operation event register
      :CONDition?                        read operation condition register
      :ENABle <number>                   set operation enable mask
   :QUEStionable
      [:EVENT]?                          read/clear questionable event register
      :CONDition?                        read questionable condition register
      :ENABle                            set questionable enable mask
                                         :PRESet   clear enable masks
SYSTem
:BEEPer <freq>,<length>                  <Freq> ignored
:DATE <year>,<month>,<day>               system date
:ERRor?                                  returns <error#,"descr;info"> or 0,"No
Error"
:KLOCk ON|OFF|1|0                        keyboard lock
:TIME <hour>,<minute>,<sec>              system time
:VERSion?                                SCPI protocol version (returns 1991.0)
:LANGuage "COMP"|"6610"|"SCPI"           set interface emulation
:PRESet                                  reset pressure control
:COMMunicate
   :SERial
      :RECeive
      :TRANsmit
            :BAUD <number>
            :PARITY EVEN|ODD|NONE
            :BITS 7|8
            :SBITs 1|2
   :GPIB
      :ADDRess <number>
TEST
   :ELECtronic?                          Run Elec Self-Test & Return Result
   :STOP                                 Abort Pneu, Volume, or Leak

UNIT
:AERonautical FTKNTS                     Feet, Knots
:AERonautical FTMPH                      Feet, Miles/hour
:AERonautical MKPH                       Meters, Kilometers/hour
:AERonautical MKPH(M/min)                Meters, Meters/minute
:AERonautical MKPH(M/s)                  Meters, Meters/second
:AERonautical MKPH(hM/min)               Meters, Hectometers/minute
:DEFine<n> <name>,<number>               Create Unit
:DISPlay <name>                          Ps Units on Display
:DISPlay11 <name>                        Qc Units on Display
```

```
:LENGth MM|IN                          set length units (head height)
[:PRESsure] <name>                     set pressure units
:TEMPerature C|CEL|F|FAR|K             set temperature units
:VACuum MICRON|MTORR|PA|<name>         set vacuum units
**Units for this command are set by UNIT:AER.
```

Example SCPI Commands

To request the current pressure reading, all of the following commands are equivalent:

:MEASURE:PRESSURE?
:measure:pressure?
:MeAsUrE:pReSsUrE?
:meas:pres?
:measure?
:meas?
MEAS?

To set the control pressure setpoint to 50, all of the following commands are equivalent:

SOURCE:PRESSURE:LEVEL:IMMEDIATE:AMPLITUDE 50
SOUR:PRES:LEV:IMM:AMPL 50.0
PRESSURE +50
PRES 50

To zero the unit via the remote interface use the following sequence:

CAL:ZERO:INIT	Enter Zero Mode
CAL:ZERO:INIT?	Read Status (Mode, Pressure, Temperature, Reference) and Wait Until Stable.
CAL:ZERO:RUN	Start Zero Adjust Sequence
STAT:OPER:COND?	Wait Until Complete (Bit 0 = 0)

SCPI Status Registers

Three type of status registers are available: Condition, Event, and Enable.

Condition registers always show the current status of the instrument. Bits may turn on and back off between reads. The status read is the status of instrument at the moment of the read. Condition registers include:

*STB? Status Byte Register
*ESR? Standard Event Status Register
STAT:OPER:COND? Operation Status Condition Register
STAT:QUES:COND? Questionable status Condition Register

Event registers do not show the current state but flag the bits in the condition registers that have changed since the last time the event register was read. When an event register is read it is reset to zero.

STAT:OPER:EVENT? Operation Status Event Register
STAT:QUES:EVENT? Questionable Status Event Register

Enable registers are set by the user to create summary bits. If the user sets a bit in the enable register, when the instrument sets the corresponding bit in the event register a summary bit in the Status Byte Register is set.

*ESE
STAT:OPER:ENAB
STAT:QUES:ENAB

The Service Request Enable Register (*SRE) is used to generate service requests on the IEEE-488 bus. If a user sets a bit in this register, when the instruments sets the corresponding bit in the Status Byte Register (*STB) a service request is generated.

*SRE

Status Byte (*STB)

Bit 7 Operation Summary
Bit 6 Service Request
Bit 5 Event Summary
Bit 4 Message Available
Bit 3 Questionable Summary
Bit 2 Error Available
Bit 1 reserved
Bit 0 reserved

Event Status Register (*ESR)

Bit 7 Power lost
Bit 6 reserved
Bit 5 Command error
Bit 4 Execution error
Bit 3 Device error
Bit 2 Query error
Bit 1 reserved
Bit 0 Operation Complete

Operation Status Register (STAT:OPER)

Bit 14 Program running
Bit 13 reserved
Bit 12 reserved
Bit 11 reserved
Bit 10 reserved
Bit 9 reserved
Bit 8 Self-Test running
Bit 7 reserved
Bit 6 reserved
Bit 5 reserved
Bit 4 Measuring
Bit 3 reserved
Bit 2 Qc Settling
Bit 1 Ps Settling
Bit 0 Calibrating

Questionable Status Register (STAT:QUES)

Bit 14 Command Warning
Bit 13 reserved
Bit 12 reserved
Bit 11 reserved
Bit 10 reserved
Bit 9 reserved
Bit 8 Pressure reading questionable
Bit 7 Pressure not calibrated
Bit 6 reserved
Bit 5 reserved
Bit 4 reserved
Bit 3 Oven temperature questionable
Bit 2 Time not set
Bit 1 reserved
Bit 0 Supply voltages questionable

Serial Operation

The RS-232 port accepts the same SCPI commands as the IEEE-488 port. The commands can be terminated by a carriage return (hexadecimal 0D) or a line feed (hexadecimal 0A). The responses are always terminated by a carriage return followed by a line feed.

The serial port also supports XON/XOFF. When the XOFF (hexadecimal 13) command is received, the ADTS will stop transmitting. Transmission is restarted when the XON (hexadecimal 11) command is received.

When only one unit is attached, the Control-C (hexadecimal 03) command will clear the transmit and receive buffers and disable addressing. When addressing is disabled, the unit will respond to commands without being addressed.

Sample Programs

Sample Program 1 — RUSKA 7750i GPIB (IEEE-488) — Controls Pressure to 20.000 %FS

```
/*----------------------------------------------------------------------*/
/*      Sample Program 1 - 7750 GPIB (IEEE-488)                         */
/*                                                                      */
/*      Controls pressure to 20.000 %FS                                 */
/*----------------------------------------------------------------------*/
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <conio.h>

#include "decl.h"

/*----------------------------------------------------------------------*/

int    device;                  /* GPIB Device descriptor */
char   buffer[256];             /* buffer for input/output strings */
double pressure;                /* Pressure read from unit */
int    status;                  /* Status register from unit */

int    check_errors (void);
void   write_7000 (char *s);
void   request_7000 (char *s);
/*----------------------------------------------------------------------*/
void main (void)
{
   char *p;
   /*---------------------------*/
   /* Initialize GPIB Interface */
   /*---------------------------*/
   device = ibdev (0,                /* First GPIB Board */
                   4,                /* GPIB Address of 7010 */
                   NO_SAD,           /* No secondary addressing */
                   T1s,              /* 1 Second Timeout */
                   0,                /* No automatic EOI for transmit */
                   REOS+LF);         /* Terminate read on Line Feed */
    if (ibsta & ERR)
      { printf ("GPIB Driver not installed.\n");
        return;
      }
   /*-------------------------------------------------------------*/
   /* Initialize 7750 Interface                                   */
   /*                                                             */
   /*     UNIT %FS           Set units to percent of full scale */
   /*     PRES 20.0          Set control setpoint to 20 %FS     */
   /*     PRES:TOL 0.001     Set control tolerance to 0.001 %FS */
   /*     OUTP:MODE CONTROL  Enter control mode                 */
   /*-------------------------------------------------------------*/
   write_7000 ("UNIT %FS;:PRES 20.0;TOL 0.001;:OUTP:MODE CONTROL\n");
   if (check_errors ( ))
      { ibonl (device, 0);
        return;
```

```
      }
      /*-----------------------------------------------*/
   /* Read pressure status until setpoint is reached. */
   /*                                                 */
   /*     MEAS?              Read pressure            */
   /*     STAT:OPER:COND?    Read status setpoint     */
   /*-----------------------------------------------*/
   while (!kbhit ( ))
      { request_7000 ("MEAS?;:STAT:OPER:COND?\n");
        pressure = strtod (buffer, &p);
        status   = atoi (++p);

        if (check_errors ( ))
           continue;

        if (status & 0x10)
           printf ("Pressure = %9.3lf\n", pressure);
        if ((status & 2) == 0)
           break;
      }

   /*-----------------------------------------*/
   /* Reset 7750 to Measure mode              */
   /*                                         */
   /*     OUTP:MODE MEASURE  Enter Measure mode */
   /*-----------------------------------------*/
   write_7000 ("OUTP:MODE MEASURE\n");

   check_errors ( );

   /*----------------------*/
   /* Reset GPIB Interface */
   /*----------------------*/
   ibonl (device, 0);
}

/*-------------------------------------------------------------------------*/
/* check_errors : display all GPIB and 7750 error messages                 */
/*                return TRUE if any errors were found                     */
/*-------------------------------------------------------------------------*/
int check_errors (void)
{
   unsigned char status7;
   int retval;

   /*---------------------------------*/
   /* Check for GPIB Interface Errors */
   /*---------------------------------*/
   if (ibsta & ERR)
      { printf ("GPIB Status=%4X Error=%d\n");
        return 1;
      }

   /*------------------------*/
   /* Check for 7750 Errors */
   /*------------------------*/
   retval = 0;
   while (!kbhit ( ))
      { ibrsp (device, &status7);                  /* Serial poll */
        if ((status7 & 4) == 0)                    /* Check error bit */
           break;
        retval = 1;
        request_7000 ("SYST:ERR?\n");            /* Get error message */
        printf (buffer);
      }
   return retval;
}
/*-------------------------------------------------------------------------*/
/* write_7000 : write a command to the 7250                                */
/*-------------------------------------------------------------------------*/
void write_7000 (char *s)
{
   ibwrt (device, s, strlen (s));
}
```

```
/*---------------------------------------------------------------------*/
/* request_7000 : write a query command and read the response          */
/*---------------------------------------------------------------------*/
void request_7000 (char *s)
{
   ibwrt (device, s, strlen (s));
   ibrd (device, buffer, sizeof (buffer));
}
/*---------------------------------------------------------------------*/
```

Sample Program 2 — RUSKA 7750i GPIB (IEEE-488) — Zero Sequence

```
/*---------------------------------------------------------------------*/
/*      Sample Program 2 - 7750 GPIB (IEEE-488)                        */
/*                                                                     */
/*      Zero Sequence                                            */
/*---------------------------------------------------------------------*/
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <conio.h>

#include "decl.h"

/*---------------------------------------------------------------------*/

int    device;                 /* GPIB Device descriptor */
char   buffer[256];            /* buffer for input/output strings */
double pressure;               /* Pressure read from unit */
int    status;                 /* Status register from unit */

int    check_errors (void);
int    zero (void);
void   write_7000 (char *s);
void   request_7000 (char *s);
/*---------------------------------------------------------------------*/

void main (void)
{
   char *p;

   /*---------------------------*/
   /* Initialize GPIB Interface */
   /*---------------------------*/
   device = ibdev (0,                /* First GPIB Board */
                   4,                /* GPIB Address of 7750 */
                   NO_SAD,           /* No secondary addressing */
                   T1s,              /* 1 Second Timeout */
                   0,                /* No automatic EOI for transmit */
                   REOS+LF);         /* Terminate read on Line Feed */
    if (ibsta & ERR)
      { cprintf ("GPIB Driver not installed.\n");
        return;
      }

   /*-----------*/
   /* Zero 7010 */
   /*-----------*/
   if (!zero ( ))
      { ibonl (device, 0);
        return;
      }
   /*-----------------------*/
   /* Reset GPIB Interface */
   /*-----------------------*/
   ibonl (device, 0);
}

/*---------------------------------------------------------------------*/
/* Zero : perform zero adjust of 7750                                  */
/*---------------------------------------------------------------------*/
int zero (void)
{
   int cstat, pstat, tstat, rstat;
```

```
   clrscr ( );
   cprintf ("Zeroing");

   gotoxy (1, 5); cprintf ("Pressure Reading");
   gotoxy (1, 6); cprintf ("Sensor Temperature");
   gotoxy (1, 7); cprintf ("Reference Pressure");

   /*-------------------*/
   /* Enter Zero Mode   */
   /*     CAL:ZERO:INIT */
   /*-------------------*/
   write_7000 ("CAL:ZERO:ALL:INIT\n");

   /*---------------------------*/
   /* Wait for zero to complete */
   /*     STAT:OPER:COND?       */
   /*---------------------------*/
   do
      { request_7000 ("STAT:OPER:COND?\n");
        sscanf (buffer, "%d", &status);

        if (check_errors ( ))
           return 0;

        gotoxy (1, 9);
        cprintf ("Zeroing");
      }
   while ((status & 1) != 0);

   gotoxy (1, 9);
   cprintf ("Zero Complete");
   return 1;
}

/*-----------------------------------------------------------------------*/
/* check_errors : display all GPIB and 7750 error messages               */
/*                return TRUE if any errors were found                   */
/*-----------------------------------------------------------------------*/

int check_errors (void)
{
   unsigned char status7;
   int retval;

   /*---------------------------------*/
   /* Check for GPIB Interface Errors */
   /*---------------------------------*/
   if (ibsta & ERR)
      { cprintf ("GPIB Status=%4X Error=%d\r\n", ibsta, iberr);
        return 1;
      }
   /*-----------------------*/
   /* Check for 7750 Errors */
   /*-----------------------*/
   retval = 0;
   while (!kbhit ( ))
      { ibrsp (device, &status7);                  /* Serial poll */
        if ((status7 & 4) == 0)                    /* Check error bit */
           break;
        retval = 1;
        request_7000 ("SYST:ERR?\n");            /* Get error message */
        cprintf (buffer);
      }
   return retval;
}

/*-----------------------------------------------------------------------*/
/* write_7000 : write a command to the 7250                              */
/*-----------------------------------------------------------------------*/
void write_7000 (char *s)
{
   ibwrt (device, s, strlen (s));
}
/*-----------------------------------------------------------------------*/
```

```
/* request_7000 : write a query command and read the response         */
/*-------------------------------------------------------------------*/
void request_7000 (char *s)
{
   ibwrt (device, s, strlen (s));
   ibrd (device, buffer, sizeof (buffer));
}
/*-------------------------------------------------------------------
--*/
```

Sample Program 3 — RUSKA 7750i Serial (RS-232) — Controls Pressure to 20.000 %FS

```
/*-------------------------------------------------------------------*/
/*      Sample Program 3 - 7750 Serial (RS-232)                      */
/*                                                                   */
/*      Controls pressure to 20.000 %FS                              */
/*-------------------------------------------------------------------*/
#include <stdio.h>
#include <stdlib.h>
#include <conio.h>
#include <dos.h>
#include <time.h>

#define TRUE 1
#define FALSE 0

#define TIMEOUT (CLK_TCK * 5)   /* 5 second timeout */
#define XON 0x11
#define XOFF 0x13
#define CLEAR 0x03
#define DLE 0x10
#define QUEUE_SIZE 1024

char   buffer[QUEUE_SIZE];      /* buffer for input/output strings */
double pressure;                /* Pressure read from unit */
int    status;                  /* Status register from unit */

int  address;
int  portbase;
int  intnum;
volatile int  transmit_enabled = TRUE;
char inqueue[QUEUE_SIZE];
int  inq_in;
int  inq_out;
void interrupt (*old_vector) ( );

int  check_errors (void);
void serial_initialize (void);
void write_7000_serial (char *s);
void serial_close (void);
int request_7000_serial (char *s);
void serial_write (char ch);

/*-------------------------------------------------------------------*/
void main (void)
{
   char *p;

   /*-----------------------------*/
   /* Initialize Serial Interface */
   /*-----------------------------*/
   address = 4;
   serial_initialize ( );

   /*-----------------------------------------------------------*/
   /* Initialize 7750 Interface                                 */
   /*                                                           */
   /*     UNIT %FS           Set units to percent of full scale */
   /*     PRES 20.0          Set control setpoint to 20 %FS     */
   /*     PRES:TOL 0.001     Set control tolerance to 0.001 %FS */
   /*     OUTP:MODE CONTROL  Enter control mode                 */
   /*-----------------------------------------------------------*/
   write_7000_serial ("UNIT %FS;:PRES 20.0;TOL 0.001;:OUTP:MODE CONTROL\n");
```

```
   if (check_errors ( ))
      { serial_close ( );
        return;
      }

   /*-----------------------------------------------*/
   /* Read pressure status until setpoint is reached. */
   /*                                               */
   /*     MEAS?              Read pressure          */
   /*     STAT:OPER:COND?    Read status setpoint   */
   /*-----------------------------------------------*/
   while (!kbhit ( ))
      { if (!request_7000_serial ("MEAS?;:STAT:OPER:COND?\n"))
           { printf ("Timeout\n");
             continue;
           }
        pressure = strtod (buffer, &p);
        status   = atoi (++p);

        if (check_errors ( ))
           continue;

        if (status & 0x10)
           printf ("Pressure = %9.3lf\n", pressure);
        if ((status & 2) == 0)
           break;
      }

   /*-----------------------------------------*/
   /* Reset 7750 to Measure mode              */
   /*                                         */
   /*     OUTP:MODE MEASURE  Enter Measure mode */
   /*-----------------------------------------*/
   write_7000_serial ("OUTP:MODE MEASURE\n");
   check_errors ( );

   /*------------------------*/
   /* Reset Serial Interface */
   /*------------------------*/
   serial_close ( );
}

/*-------------------------------------------------------------------------*/
/* check_errors : display all 7750 error messages                          */
/*                return TRUE if any errors were found                     */
/*-------------------------------------------------------------------------*/
int check_errors (void)
{
   unsigned char status7;
   int retval;

   /*-----------------------*/
   /* Check for 7750 Errors */
   /*-----------------------*/
   retval = 0;
   while (!kbhit ( ))
      { if (!request_7000_serial ("*STB?\n"))
           { printf ("Timeout\n");
             return TRUE;
           }
        status7 = atoi (buffer);
        if ((status7 & 4) == 0)                    /* Check error bit */
           break;
        retval = 1;
        request_7000_serial ("SYST:ERR?\n");            /* Get error message
*/
        printf (buffer);
      }
   return retval;
}
/*-------------------------------------------------------------------------*/
/* serial_int : receive interrupt for serial port                          */
/*-------------------------------------------------------------------------*/
```

```
void interrupt serial_int ( )
{
   char ch;

   if ((inportb (portbase + 2) & 0x07) == 0x04)
      { ch = inportb (portbase);
        if (ch == XON)
           transmit_enabled = TRUE;
        else if (ch == XOFF)
           transmit_enabled = FALSE;
        else
           { inqueue[inq_in++] = ch;
             if (inq_in == QUEUE_SIZE)
                inq_in = 0;
           }
      }
   outportb (0x20, 0x20);
}
/*-------------------------------------------------------------------------*/
/* serial_initialize : initialize serial port                              */
/*-------------------------------------------------------------------------*/
void serial_initialize ( )
{
   char msg[10];
   int divisor;
   unsigned v;


   portbase = 0x3F8;                    /* COM1 = 0x3F8, COM2 = 0x2F8 */
   intnum   = 4;                        /* COM1 = 4,     COM2 = 3     */
   outportb (portbase + 3, 0x80);
   outportb (portbase + 1, 0);
   outportb (portbase,     0x0C);       /* 9600 Baud */
   outportb (portbase + 3, 3);          /* 8 Databits, No Parity, 1 Stopbit
*/

   old_vector = getvect (intnum + 8);   /* Save old interrupt vector */
   setvect (intnum + 8, serial_int);    /* Set new interrupt vector */

   v = inportb (0x21);                  /* Enable interrupt */
   v &= ~(1 << intnum);
   outportb (0x21, v);

   outportb (portbase + 1, 0x01);       /* Enable receive interrupt */
   outportb (portbase + 4, 0x0B);       /* Enable Interrupt, DTR, RTS */

   serial_write (CLEAR);
}
/*-------------------------------------------------------------------------*/
/* serial_close : turn off serial receive interrupt                        */
/*-------------------------------------------------------------------------*/
void serial_close ( )
{
   unsigned v;

   outportb (portbase + 1, 0);
   outportb (portbase + 4, 0);
   v = inportb (0x21);
   v |= 1 << intnum;
   outportb (0x21, v);
   setvect (intnum + 8, old_vector);
}
/*-------------------------------------------------------------------------*/
/* serial_write : write a single character to serial port                  */
/*-------------------------------------------------------------------------*/
void serial_write (char ch)
{
   while (!transmit_enabled)
      ;
   while ((inportb (portbase + 5) & 0x20) == 0)
      ;
   outportb (portbase, ch);
}
/*-------------------------------------------------------------------------*/
```

```
/* write_7000_serial : write a string to the correct 7750             */
/*--------------------------------------------------------------------*/
void write_7000_serial (char *s)
{
   if (address == -1)
      serial_write (CLEAR);             /* Disable Addressing */
   else
      { serial_write (DLE);             /* Enable Addressing */
        serial_write (address + 0x20);  /* Address */
      }
   while (*s)                           /* Write string */
      serial_write (*s++);
}
/*--------------------------------------------------------------------*/
/* request_7000_serial : write a commmand and read the response       */
/*--------------------------------------------------------------------*/
int request_7000_serial (char *s)
{
   int i;
   char ch;
   clock_t start, current;

   write_7000_serial (s);               /* Write Command */
   i = 0;
   while (i < QUEUE_SIZE - 1)
      { start = clock ( );
        while (inq_in == inq_out)               /* Wait for a character */
           { current = clock ( );
             if (current < start)
                current += CLK_TCK * 86400;
             if (current - start > TIMEOUT)     /* Check for timeout */
                { buffer[i] = 0;
                  return FALSE;
                }
           }
        ch = inqueue[inq_out++];        /* Put character in buffer */
        if (inq_out == QUEUE_SIZE)
           inq_out = 0;
        if (ch == 0x0A)                 /* Line Feed? - End of response */
           { buffer[i] = 0;
             return TRUE;
           }
        else
           buffer[i++] = ch;
      }
   buffer[QUEUE_SIZE - 1] = 0;          /* Buffer full */
   return FALSE;
}
/*--------------------------------------------------------------------*/
```

Sample Program 4 — QBASIC Example for RUSKA 7750i

```
REM $INCLUDE: 'C:\GPIB-PC\QBDECL.BAS'
DIM READING AS STRING*30
CALL IBDEV(0,4,0,12,1,&H40A,R7010%)
CALL IBCLR(R7010%)
CALL IBWRT(R7010%,"MEAS?" + chr$(&H0A))
CALL IBRD(R7010%,READING$)
PRINT READING$
CALL IBONL(R7010%,0)
END
```

Note: EOM & EOS are linefeed

Chapter 6
Maintenance

Introduction

Very little maintenance is required for the ADTS. This section of the manual discusses suggested maintenance procedures.

Observing the Software Version Number

Follow the steps below to observe the ADTS's software version number.

1. If necessary, press PREVIOUS several times to return the display to the Main Dual Display Menu.
2. Select MENU | MENU | SETUP | SYSTEM. The software version number will appear on the screen.
3. Press PREVIOUS to return to the previous screen.

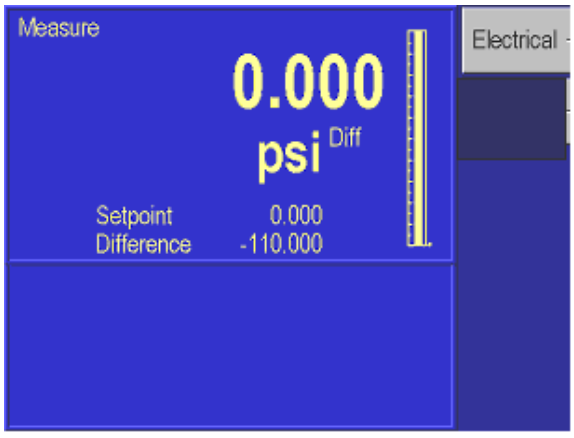
Preventive Maintenance

Although the ADTS is designed to be nearly maintenance free, occasional preventive maintenance is required to keep the ADTS's performance optimal.

Initiating the ADTS's Self Test

To test the ADTS's hardware and software follow the steps below.

1. If necessary, press PREVIOUS several times to return the display to the Main Dual Display Menu then press the MODE key to select the channel main menu.
2. Select MENU | MENU | TEST | SELF



gme28.bmp

Figure 6-1. Menu | Menu | Test | Self

3. Press ELECTRICAL [F1]. The electronics self test will run and display the results.

The electronics test runs eight sets of tests on various parts of the electronic modules. Table 6-1 describes these tests and the possible actions needed if a test fails.

Table 6-1. Electronics Self Test

Test	Description	Action on failure
Processor	Tests the processor chip.	Replace processor board.
Clock	Tests the real time clock.	Replace processor board.
High	Tests the Ps sensor.	Contact factory.
Low	Tests the Qc sensor.	Contact factory.
Control	Tests the Ps & Qc controller boards.	Contact factory.

Removing the ADTS's Cover

The ADTS should be kept clean and completely assembled at all times. Operating the ADTS without its cover affects the ADTS's thermal gradients and therefore may reduce precision. If it becomes necessary to remove the ADTS's cover, follow the instructions below.

⚠⚠ Warning

The ADTS should only be opened by qualified electrical/mechanical service technicians. Lethal voltages are present and exposed in the power supply and display.

1. Turn off the ADTS and disconnect the power cord from the ADTS.
2. Locate and unscrew the four screws that secure the cover to the back panel.
3. Place your hands near the middle of the cover and slide the cover towards the ADTS's back panel.
4. Lift up on the cover. With the cover removed, use typical electronic cleaning tools to remove any accumulated dust from inside the instrument.
5. Replace the cover before resuming operation.

Particle Filters

Refer to Appendix A for air supply quality requirements. During normal operation, the ADTS transfers gas both into and out of the device under test (DUT). When necessary, the user is expected to use and maintain an in-line disposable particle filter to protect the ADTS's pneumatics from any contamination that may exist in the DUT.

Vacuum Pumps

Periodic checks of the user's vacuum pumps for oil levels. It is very highly recommended that a power-down vacuum-venting valve is installed onto the vacuum pump to ensure minimal chances of oil contamination from the vacuum sources. These are normally open solenoid valves that are powered through the vacuum pump power switch. When the vacuum pump is turned on, the solenoid valve is energized and closes allowing the pump to operate normally. When the pump is turned off, power is removed from the solenoid and the vacuum is vented to atmosphere. Periodic changing of vacuum pump oil should also be done as recommended by the vacuum pump manufacturer.

Processor Battery

The processor board uses a lithium battery to maintain time and date information. This battery has a varying life. If the instrument is left on 24 hours a day, it may last 5 to 10 years. If the instrument is stored, it may only last one year. Annual replacement is recommended. To replace the battery:

1. Turn off power and remove the instrument cover. (See Chapter 6, Removing the ADTS's Cover)
2. Remove the processor card by removing the screw and the bracket that locks the display cable in place and gently rock the card upward.
3. Holding the processor card, remove the battery (the round silver object), by carefully pulling on the battery.
4. Plug in a new battery (part number 4-725).
5. Reinstall the processor card, the bracket that locks the display cable in place and the screw. Replace the instrument cover.
6. The time and date may have to be re-entered. See Chapter 4, Menu | Setup – System.

Calibration

To keep the ADTS operating within its specified precision, the calibration procedure described below should be performed once every year. If a higher level of overall performance is desired, the user can calibrate more frequently.

Note

The calibration procedure automatically generates coefficients that are stored in memory on the ADTS. If these constants are "lost" for any reason, the calibration procedure must be performed, regardless of the last calibration date. If the calibration coefficients have been recorded, they may be restored to the ADTS at any time by "editing the coefficients." (Chapter 6, Editing the Calibration Coefficients).

Calibration Instructions

To calibrate the ADTS, the user connects a calibration standard such as the RUSKA Model 2465 or 2468 Gas Piston Gauge to the ADTS's test port, then follow the multi-step calibration procedure on the ADTS's display. No disassembly is required and there are no potentiometers to tune.

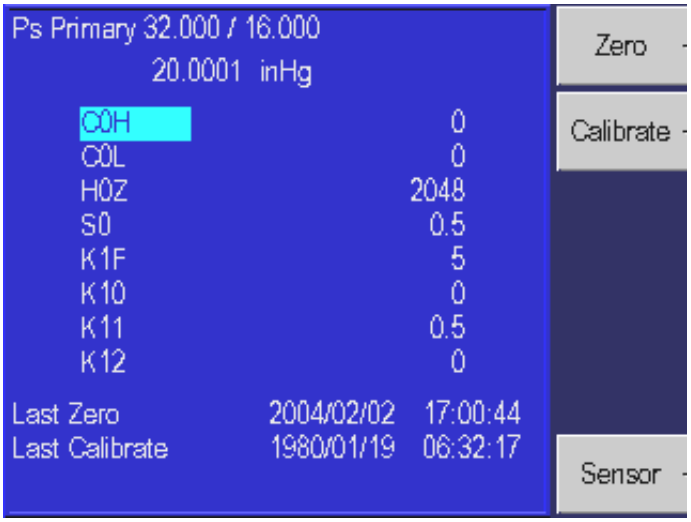
Note

The uncertainty of the final calibration must include the uncertainty of the pressure standard being used.

Preparation

1. When calibrating the Qc channel, verify that the Ps Test Port is open to atmosphere and that the calibration standard is connected to the Pt Test Port. When calibrating the Ps channel, verify that the calibration standard is connected to the Ps test port.
2. Verify that the ADTS has been at stable environmental temperature and that the oven temperature (MENU | MENU | DISPLAY | TEMPERATURE) has been stable for at least three hours.
3. Verify that the ADTS is in Measure mode (Chapter 4).
4. If desired, change the ADTS's engineering units of measure (Chapter 4) to match those of the calibration standard.

5. Set the gas head to 0 for both channels. Select MENU | MENU | SETUP | USER (Press the MODE key to toggle between the Ps and the Qc channels and verify that they are both set to 0.)
6. To access the calibration screen, select MENU | MENU | CALIBRATION | CALIBRATION.



gme29.bmp

Figure 6-2. Menu | Menu | Calibration | Calibration

7. When first entering the Calibration menu, the top left hand side of the display will indicate which sensor is being the viewed. The sensors coefficients are then shown below the sensor label. On the RUSKA 7750i, there are two primary sensors. The first sensor that is shown is the Ps sensor. To switch to the Qc sensor, press the Sensor [F6] function key. Ensure that the correct screen is displayed, (labeled Ps Primary or Qc Primary), depending on which channel is being calibrated.
8. To begin the calibration process, press the Calibrate [F2] button. If the calibration access code is enabled, enter it at the prompt. The first calibration screen will appear.

Note

To exit the calibration procedure before the calibration coefficients have been changed; press [CANCEL] any time during the procedure. Canceling restores all previous calibration values.

Step 1

1. The first step automatically performs the sensor zeroing routing. Please read the chapter in the manual regarding zeroing the sensors. It is critical that a good zero is set in the calibration process. The Ps sensor must be evacuated to less than 100 mtorr as read by the internal vacuum sensor and stable before proceeding with a zero. It is recommended to start evacuating the Ps sensor during the warm up period.
2. Wait until the zero procedure finishes. This may take several minutes. When the ADTS completes step 1, the calibration screen will appear.

Step 2

1. To begin step 2, use the calibration standard to apply the various pressures that will be requested by the RUSKA 7750i. The screen will display a table noting the following information.

Step	The pressure step in the calibration sequence
Apply	The pressure that the standard is to generate to the ADTS.
Tolerance	The tolerance about the apply value that can be generated by the standard and still accepted by the ADTS.
Actual	The actual pressure value that was generated by the standard when the point was accepted.
Adj. %FS	Depicts the amount that the ADTS corrected its output to align to the standard. This is used as a trouble-shooting tool. If one point has a significantly higher adjustment required than other points in the calibration, this may indicate that there was an error in that specific calibration point. The operator can re-check this pressure point prior to completing and accepting the full calibration.

2. The Step 1, actual value will be highlight. This is your first pressure point in the calibration procedure.
3. Using your calibration standard, generate the pressure shown in the Apply column. When the measured pressure stabilizes, use the ADTS's numeric keypad to enter the actual pressure applied by the calibration standard and then press ENTER. Do not enter the measured pressure reported by the ADTS. If necessary, use the CLEAR key to correct a mistake in the edit field. If the actual pressure applied is within the indicated tolerance, the unit will accept that point and the highlighted curser will automatically scroll down to the next calibration step.

Note

If the actual pressure is outside of the tolerance for the requested mid-point pressure, Error — 222 Data out of range will occur. Acknowledge this error by selecting OK [F6], then re-enter the actual pressure, repeating Step 2, number 1, if necessary.

Step 3

1. Generate the next pressure calibration point requested by the ADTS. Apply this pressure using calibration standard and follow the instructions in Step 2, number 3, entering the actual pressure applied.
2. Repeat this procedure until all of the calibration steps are complete. Review the Adj. %FS field to see if one point has a significantly higher adjustment required than other points in the calibration. This may indicate that there was an error in that specific calibration point. The operator can re-check this pressure point prior to completing and accepting the full calibration. To re-enter a point, use the rotary knob and move the highlighted curser to the actual pressure values in the step in question. Generate the requested apply pressure using the standard and enter then new actual value when stabilized.

Storing the Coefficients

Step 4

1. Calibration is complete. To exit the calibration procedure without storing the calibration coefficients in memory, press CANCEL. To store the calibration coefficients in memory, select the Done [F1] key and the ADTS will calculate all of its new coefficients.

Note

In additional to saving the calibration coefficients to the ADTS's memory, the user is advised to separately record the calibration coefficients and store this "backup" in a safe place.

Step 5

1. Press PREVIOUS to return to the Main Menu.
2. Once the calibration procedure is complete, the user should verify several pressure readings against the pressure standard. If there are variances beyond the stated precision, then an error was probably made in generating one of the calibration pressures, and the calibration procedure should be repeated.

Vacuum Sensor Calibration — Ps Zeroing Vacuum Sensor

A span correction can be applied to the vacuum sensor. This correction is done using the ADTS software and can be performed without removing the vacuum sensor from the ADTS chassis.

1. Place the ADTS in Measure mode. Remove all pressure sources from the system.
2. Connect a vacuum standard to the Ps Port on the rear of the unit. Pump the instrument down for at least 12 hours.
3. If desired, change the ADTS's units of measure (see Chapter 4) to match those of the calibration standard.
4. To access the Calibration screen, from the Main Menu, select MENU | MENU | CALIBRATE | SENSOR | SENSOR | CALIBRATE.
5. To begin the calibration process, press CALIBRATE. If the calibration access code is enabled, enter it at the prompt. The first Calibration screen will appear.
6. Use the pressure standard to generate the first of two pressure points. The two pressure points are typically 100 and 200 mtorr absolute. Enter the actual value of the applied pressure generated by the standard and press ENTER.
7. Generate the second pressure. Enter the actual value of the applied pressure generated by the standard and press ENTER.
8. The Vacuum sensor is now linearly compensated. Once the calibration procedure is complete, the user should verify several pressure readings against the pressure standard. If there are variances beyond the stated precision, then an error was probably made in generating one of the calibration pressures, and the calibration procedure should be repeated.
9. Remove the vacuum standard from the instrument.
10. Reinstall the cover onto the RUSKA 7750i.

Editing the Calibration Coefficients

If the ADTS's memory is erased but the calibration coefficients are known, the user can restore the coefficients to the ADTS by following the directions below.

⚠ Caution

Never randomly adjust the calibration coefficients. Only qualified personnel with valid backup data should be allowed to edit the coefficients. If the backup coefficients are questionable, perform the calibration procedure in its entirety.

1. Verify that the ADTS is in Measure mode (Chapter 4).
2. Enter the Calibration screen by selecting MENU | MENU | CALIBRATE| CALIBRATE.
3. When first entering the Calibration menu, the top line of the display will indicate which sensor is being the viewed. The sensors coefficients are then shown below the sensor label. The first sensor that is shown is the Ps sensor. Press the Sensor [F6] function key to cycle through the various sensors that exist in the system.
4. To edit the calibration coefficients, press the EDIT button. If the calibration access code is enabled, enter it at the prompt. The first calibration screen will appear.

Note

To exit the calibration procedure before the calibration coefficients have been changed, press [CANCEL] any time during the procedure. Canceling restores all previous calibration values.

5. Use the rotary knob to highlight the coefficient to be edited. The terms are coefficients of a linear regression analysis.
6. Use the numeric keypad and the ENTER key to enter a new value. To correct a mistake in the edit field, use the CLEAR key.
7. Repeat steps 4 and 5 until all coefficients are correct.

Note

In addition to saving the calibration coefficients to the ADTS's memory, separately record the calibration coefficients and store this "backup" in a safe place.

8. To exit the editing procedure without storing the calibration coefficients in memory, press CANCEL. To store the calibration coefficients in memory, select DONE [F6].
9. Press PREVIOUS to return to the Main Menu.
10. Once the calibration coefficients are input, the user should record several pressure readings. If there are any variances beyond the stated precision at these points, then the calibration procedure should be performed.

Zeroing

The zeroing procedure is performed to correct for system zero shift and does not require a full calibration. The most important requirement for performing a valid zeroing procedure is to guarantee that there is not a pressure differential between the sensor's test port and case reference.

If during the zeroing procedure, the message "Mechanical Zeroing Needed" appears, the sensor photocell may need to be zeroed. See Chapter 6, Sensor Photocell Zeroing, for more information.

The zeroing screen presents several pieces of information.

The screen will display the current status of the pressure sensor Stability and Temperature.

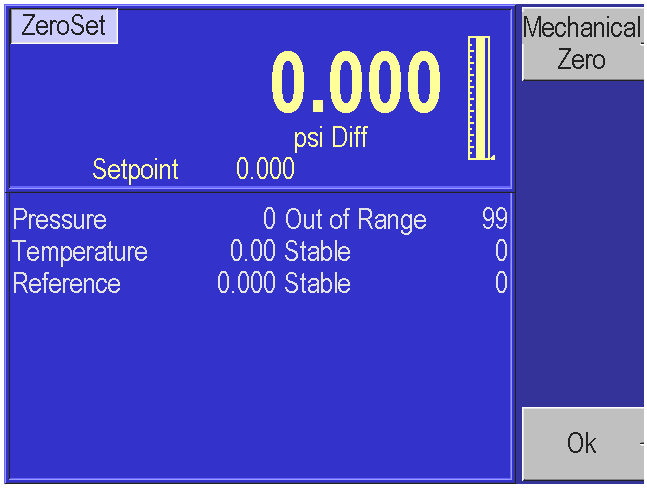
If any of the above are unstable, then the system will delay until stability is achieved. Pressing OK [F6] will bypass this wait period.

Note

Bypassing this wait period can have a negative effect on the zeroing procedure.

Qc Channel

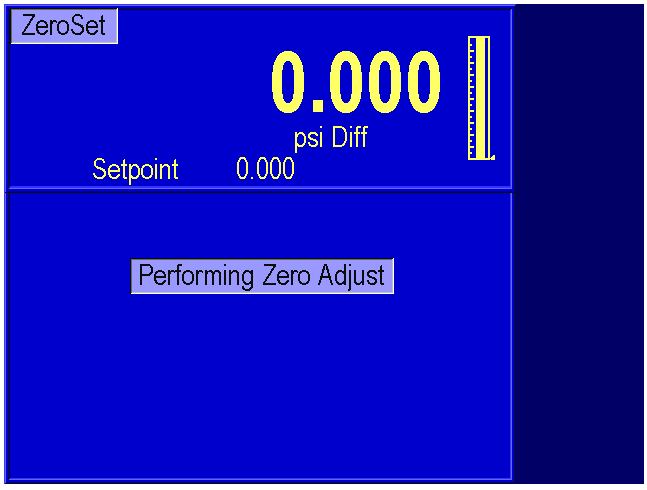
1. Verify that the Ps and Qc sensors are close to atmospheric pressure.
2. Enter the Calibration screen by selecting MENU | MENU | CALIBRATION.
3. Select Zero [F1]. Do NOT press the Calibrate button.



gme30.bmp

Figure 6-3. Menu | Menu | Calibration

4. Do not disturb the instrument while zeroing is in process.
5. Wait for the zeroing procedure to finish.



gme31.bmp

Figure 6-4. Zeroing Screen

6. Press PREVIOUS to return to the Main Menu.

Ps Absolute Sensor — VAC Level

A high capacity vacuum pump must be connected to the rear vacuum port.

The RUSKA 7750i has a Vacuum Sensor mounted internal to the primary sensor housing that monitors the vacuum level of the Ps sensor when the sensor is being zeroed. This sensor reading will display a value of 350 mtorr when the vacuum level is at or greater than 350 mtorr.

1. Select the desired vacuum units using the UNITS key. You can change both the unit of measure that the ADTS is displaying Pressure and the unit of measure for the vacuum sensor. It is not required to have the ADTS displaying pressure in the same unit of measure as the vacuum sensor. To change the unit of measure for the Vacuum sensor, press the UNIT key and then the Vacuum [F2] key.
2. Enter the Calibration screen by selecting MENU | MENU | CALIBRATE.
3. Select Zero [F1]. DO NOT press the Calibrate button. When initiating the zeroing command in the ADTS, it will cycle the internal valves allowing the external vacuum pump to pull a hard vacuum on the RUSKA sensor. It is recommended that the sensor be pulled down to a vacuum of less than 100 mtorr (preferably less than 60 mtorr) in order to obtain a proper zero. The ADTS can be zeroed at higher vacuum levels, however, the uncertainty of vacuum sensors tend to increase at higher vacuum levels, therefore, the uncertainty in the ADTS would also increase if zeroed at higher vacuum levels.
4. Wait for the vacuum level to stabilize as read by the internal vacuum sensor. Generally the stability should to be better than 5 mtorr per minute.
5. Verify that the primary sensor pressure and temperature are stable.
6. Press OK [F6] when stable.
7. Do not disturb the instrument while zeroing is in process.
8. Wait for the zeroing procedure to finish.
9. Press PREVIOUS to return to the Main Menu.

Sensor Photocell Zeroing

If the error message “Mechanical Zeroing Needed” is displayed, the sensor photocell must be zeroed. The following steps describe this process. Press the MODE key to select the desired channel.

⚠⚠ Warning

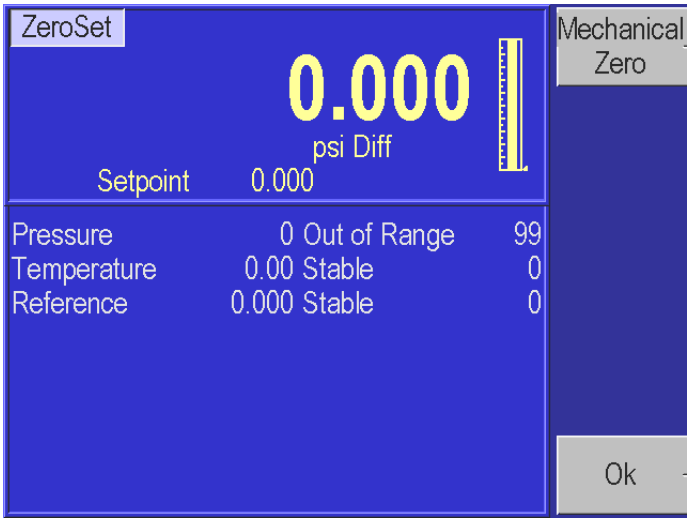
The ADTS should only be opened by qualified electrical/mechanical service technicians. Lethal voltages are present and exposed in the power supply and display.

Note

The Qc sensor MUST have zero differential pressure between the Test Pt port and Reference Ps port. The Ps sensor requires a vacuum of <200 mtorr.

1. Remove the ADTS’s top cover—the Ps sensor is located on the right, and the Qc is on the left (when viewed from the front of the unit).
2. Locate and remove the plastic zeroing plug located in the side of the sensor oven assembly.
3. Enter the Zeroing screen by selecting MENU | MENU | CALIBRATE.

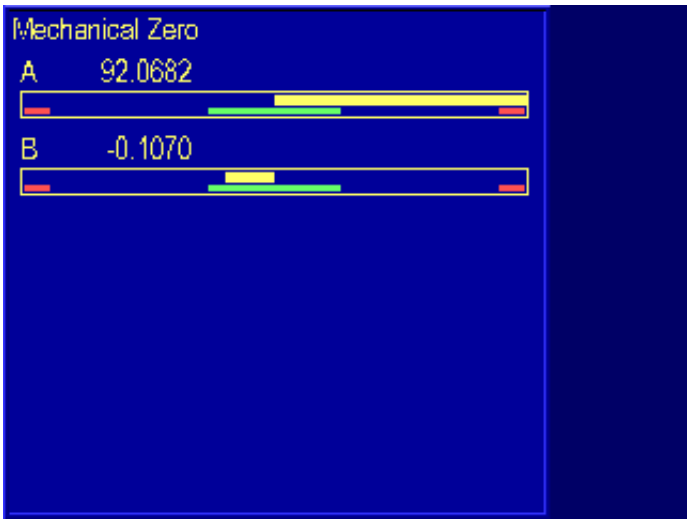
4. Select the Primary sensor by pressing the Sensor [F6] key until the words Ps Primary or Qc Primary depending on the desired sensor is displayed, above the calibration coefficients.
5. Select Zero [F1]. Do NOT press the Calibrate button.
6. Select the Mechanical Zero [F1] key.



gme32.bmp

Figure 6-5. ZeroSet Screen

7. Referring to Figure 6-8, slightly loosen the Allen screw on the back of the sensor bracket, making sure to maintain a snug fit on the screw. Using the T-shaped Photocell Centering Tool (part number 7750-111) adjust the photocells by placing the tool in the hole in the back of the sensor and turning the tool slightly. The screen will show a number of horizontal lines. The top yellow bar represents the current zero setting. The bottom portion of the bar has a green bar in the center and two red bars on either end. If the top yellow bar is over the red bar, then mechanical zeroing is required. If the yellow bar is over the green bar, then no adjustment is required.



gme33.bmp

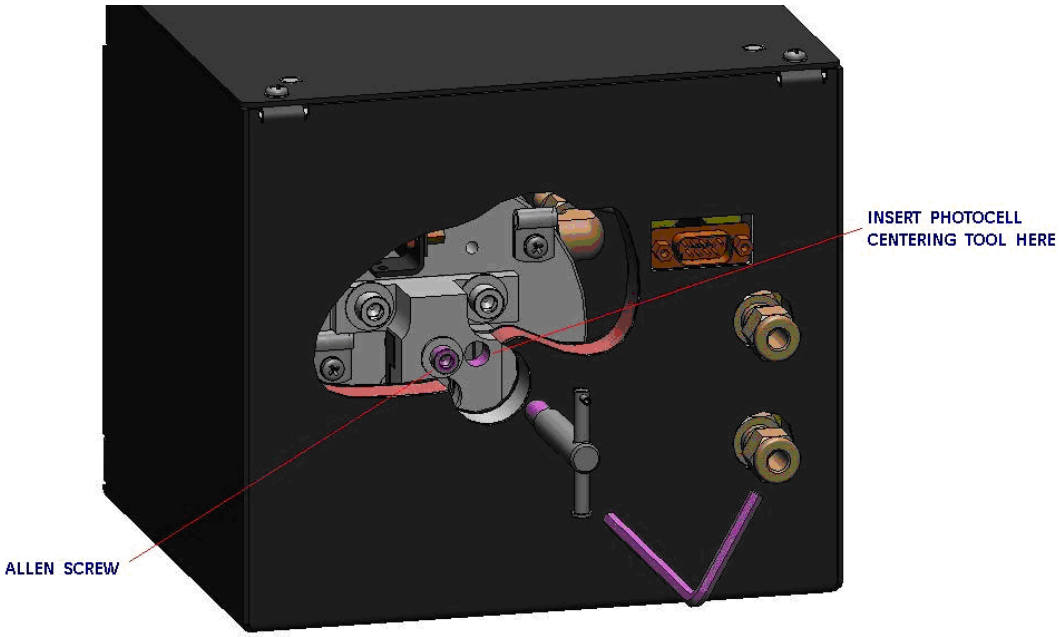
Figure 6-6. Mechanical Zeroing Screen

8. Adjusting the photocell will cause the yellow bar to reduce in width. It should be adjusted until the yellow line is as thin as possible over the green bar.

gme34.bmp

Figure 6-7. Adjusting the Photocell

9. Tighten the Allen screw.
10. Often, when the Allen screw is tightened, the zero will move. Review the width of the yellow line, again loosen the Allen screw, and now offset the yellow bar the same width that you observed it moving from tightening the Allen screw, and now offset it in the opposite direction by this same width.
11. Again, tighten the Allen screw. Now the width of the yellow line should be minimized.
12. Tap on the bracket with a screwdriver handle to relieve mechanical stress. Continue to tap on the bracket until the counts stop changing.
13. If the zero moved significantly as a result from tapping the bracket, repeat this procedure as necessary.
14. Reinstall plastic zeroing plug.
15. After the unit has become thermally stabilized, perform a normal instrument zeroing procedure. Refer to Chapter 6, Sensor Photocell Zeroing.

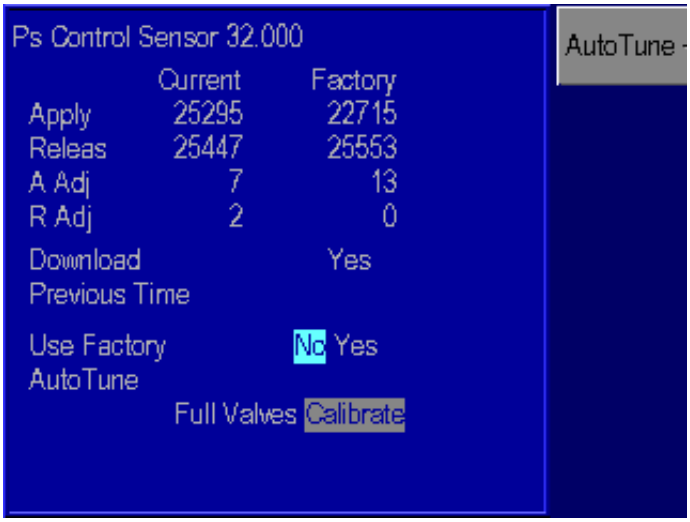


gme35.bmp

Figure 6-8. Photocell Location

Optimizing Control

The performance of the controller may be optimized for certain environments or performance criteria by adjusting the values available in the Control screen. The Control screen is available from the Main Menu by pressing Menu [F6], Test [F5], Control [F6]. The Control screen is shown below.



gme36.bmp

Figure 6-9. Menu | Menu | Test | Control

Note

Be sure the Control Band parameter is set to zero (Chapter 4, Menu; Menu | Setup; Menu | Setup — Limits; Auto Vent).

If the controller does not control optimally, it would be recommended to first assure that the system is free of leaks and is operating within the external volume specifications (see Appendix A). You should verify that the instrument is fitted with the proper sized pressure lines to minimize flow restrictions (see Chapter 3, Pneumatic Connections). Verify that the control band is set as intended (see Chapter 4, Auto Vent). For active control, when testing the controller the Control Band Off and Control Band On values should be set to zero. Finally verify that the control is set to Normal to minimum overshoot (see Chapter 4, Menu; Menu | Setup; Control Band). If the system continues to control improperly, you can perform the Auto-tune. You will need to press the MODE key to select either the Ps or the Qc channel.

There are two options available to the operator.

Full — This fully characterizes the control function of the RUSKA 7750i. It automatically adjust the control valve biases and aligns the inner loop high control pressure sensor to the high accuracy quartz sensor. This should be performed any time major components are replaced in the controller such as the control valves or the high-speed inner loop control sensor. Additionally, if the controller is not functioning properly, a full Auto-tune can be performed to optimize the control.

Calibrate — This automatically aligns the inner loop high control pressure sensor to the high accuracy quartz sensor. If in the Normal control mode (as opposed to the fast control mode), the controller overshoots the commanded pressure valve, this could be an indication that the inner loop control sensor needs to be realigned with the high accuracy quarts sensor. This is achieved by running the Calibrate Auto-Tune function.

Note

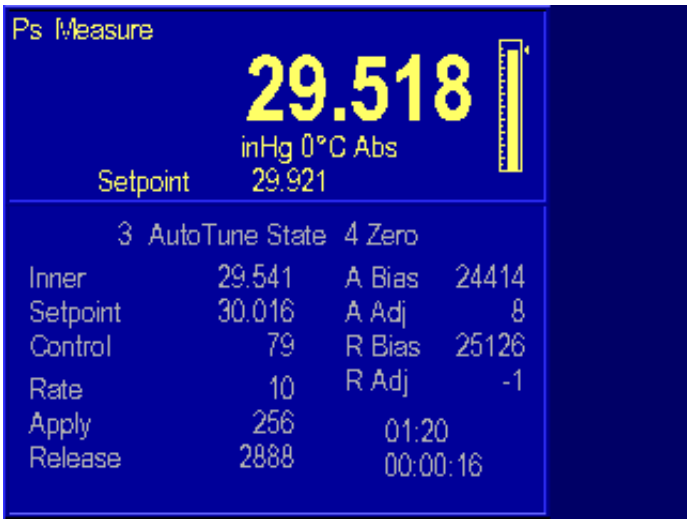
Prior to performing any Auto-Tune functions in an effort to improve the controller performance, confirm that the system is a leak free system and the volume attached to the test port is within the recommended range (see Appendix A). Additionally, assure that the system has adequate pressure and vacuum supply (when required).

To perform these Auto-Tune functions, the instrument must be connected to a pressure supply with the pressure supply set to the proper supply pressure (please refer to the specifications in Appendix A). On absolute instruments, a vacuum pump must be connected to the exhaust port.

Disconnect any device under test from the test port. The test port must be connected to a sealed volume of 5 to 15 cubic inches (80 to 240 cc's).

Use the Rotary knob to select which Auto-Tune procedure is to be performed and then press the enter key. Select Full to perform the complete Auto-Tune sequence. If selected, you are not required to run any of the other Auto-Tune functions. Press the enter key.

The ADTS with go through a sequence of controlling to various pressures and automatically adjusting the control parameters of the valves. The ADTS will display a message indicating when it is complete with the Auto-Tune procedure. The time required to complete the Auto-tune procedure can range anywhere from 1 to 2 hours.



gme37.bmp

Figure 6-10. Auto-Tune Screen

If any control valves or the high speed inner loop pressure sensor has been replaced, the Auto-Tune should be run to characterize the new hardware.

Fan Operation

When operating the system within the ambient conditions listed in the specification, the fan defaults to the "on" condition when the instrument is powered up. It has a direct impact on the chassis temperature, and an indirect effect on the sensor oven temperature.

System Software Update Procedure

Note

Calibration and other stored constants are not affected by program updates.

The update procedure requires a PC connected to the RS-232 port on the RUSKA 7750i.

(9-pin to 9-pin, null modem cable minimum pinout 2-3, 3-2, 5-5).

1. When appropriate, the latest version of the software for upgrading instruments can be e-mailed from the factory, or downloaded from the website: www.gesensing.com. The e-mail will have a zip file attached contains two files UPDATE7.EXE and <version>.IMG. Unzip these files into a directory on the PC.
2. Set the RUSKA 7750i to 9600 baud, 8 databits, no parity, 1 stopbit.
3. Run the program Update7.
4. Follow the prompts to select the communications port and the image file.
5. When the upgrade is finished, Update7 running on the PC and the RUSKA 7750i should both display Complete.

RUSKA 7750i Controller Software Upgrade

In addition to the main code, the RUSKA 7750i include code for the pressure controller. The controller software version can be viewed by pressing the MENU/TEST/REMOTE/SERIAL2 keys. The controller software version is displayed next to 'Ctrl'. This code can be upgraded through the RS-232 port on most units. Press the MENU/TEST/CONTROL key and check for 'Download Yes'.

(The digit in front of the R increases with revision levels and the last two digits will increment upwards as the revision level increases, e.g. 0R99 is older code than 1R01 which is older than 1R08, etc.)

1. Connect a PC to the RS-232 port on the RUSKA 7750i using a null modem cable.
2. The zip file labeled RUSKA 7750iControl|XRXX contains files UPDATE7.EXE and <version>.IMG. Unzip these files into a directory.
3. Set the RUSKA 7750i to 9600 baud, 8 databits, no parity, 1 stopbit.
4. Run the program Update7.
5. Follow the prompts to select the communications port and the image file.
6. Update 7 should display Complete.

Note

When updating the controller code, the RUSKA 7750i will display various error messages. This is expected. The front display will freeze on the RUSKA 7750i when the controller code is being downloaded. It will operate properly once the download is complete. Finally, the main software only reads the software versions on power-up. So, following the controller code upgrade, pressing the MENU/TEST/REMOTE/SERIAL2 keys will only show the new revision level of the controller code after power is cycled on the RUSKA 7750i.

Replacement Parts

The following is a list of the common replacement parts used in the RUSKA 7750i ADTS.

Table 6-2. RUSKA 7750i ADTS - Parts List

Description	Part Number	
	Valve Body	Valve Coil
Ps Test Valve	3961365	3915780

Ps Vent Valve	3961365	3915780
Ps Apply Valve	3961352	3915780
Ps Release Valve	3961352	3915780
Ps Zero Valve	3961376 (With Coil)	
Pt Test Valve	3961365	3915780
Pt Equalize Valve	3961365	3915780
Pt Apply Valve	3961352	3915780
Pt Release Valve	3961352	3915780

Table 6-3. RUSKA 7750i ADTS - Replacement Parts List

Description	Part Number
Power Supply	3865784
Fan Assembly	3962098
Rotary Encoder	3878927
Battery	2135249
IEEE PCB	3911212
CPU	3926985
Controller PCB - spare	3866180

Chapter 7
Preparation for Storage and Shipment

Preparation for Storage & Shipment

⚠ Caution

The procedures given in this Chapter must be strictly adhered to in order to prevent damage to the instrument. Failure to follow these procedures will likely result in damage to the ADTS during shipment. This damage is not covered by the carrier's insurance.

Disconnecting the ADTS

1. Relieve all pneumatic pressure from the ADTS.
2. Turn the ADTS power switch to the off position.
3. Disconnect the power cable from the ADTS power receptacle.
4. Disconnect all pneumatic lines from the ADTS's back panel.
5. Plug all ports.

Packing Instructions

To prevent shipping and handling damage to the instrument, adhere to and strictly follow the instructions below.

The governing discipline in ensuring a damage-free shipment is to ensure that the possibility of handling shocks to the ADTS is minimized and/or prevented during transit. This is accomplished by supporting the ADTS between two foam cradles that are encapsulated within a double-walled, corrugated box. The ADTS is restrained and supported, but still has resilience. The materials used in the packaging operation are foams that have a minimum impact rating of not less than N-95.

⚠ Caution

Styrofoam, poured "foam in place" mixtures, and other rigid foams are not recommended.

If polyfoam or rubber foam other than that used in the original packaging is to be used, cut it into strips so that it will not present a large rigid surface to the ADTS.

Fluke has found that corrugated cardboard boxes provide the best packaging exterior. The box must have an impact rating of 275 lb and be of double-walled construction. This type of box will sustain most types of damage incurred during the shipping and handling process, but ensures that the contents remain intact and damage-free. The foam cradle ensures that a minimum of 3 inches of foam separates the inner surface of the box and any portion of the ADTS.

⚠ Caution

Wood or metal boxes do not absorb shock when dropped and therefore are not recommended.

If the original packaging and shipping materials have been retained, use them for packing the ADTS. If the ADTS is being packed for long-term storage (more than 30 days), place a desiccant bag inside the box.

The ADTS must be prepared for shipment in the following manner:

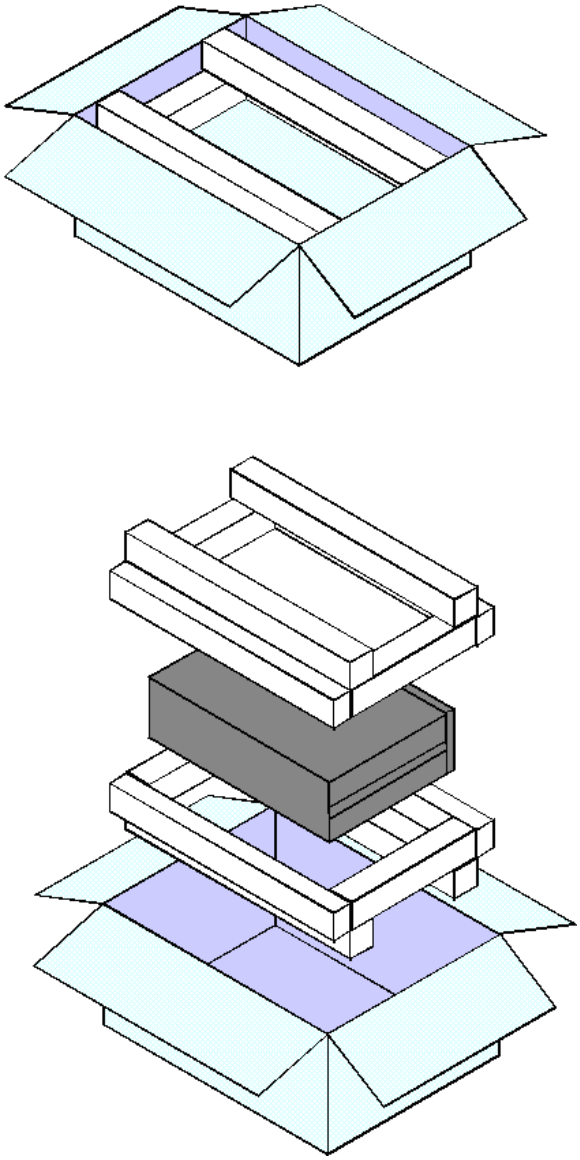
1. Fluke has an RMA procedure in place. Please contact the Customer Service Center to obtain an RMA number prior to returning any equipment. Have the following information available when contacting Fluke:
   a. the part number,
   b. the serial number,
   c. the purchase order number,
   d. the billing and ship to address, and
   e. the buyer's name and telephone number.

This information plus the RMA number must be attached to the unit when it is shipped to Fluke Calibration. There will be a minimal charge for inspection and/or evaluation of returned goods.

2. Enclose the ADTS in plastic or any good water barrier material. Antistatic material is recommended.
3. If the original shipping carton is not usable or available, use a double-walled corrugated carton with a 275-lb rating. The recommended carton size is 25 1/2 x 19 1/2 x 12 3/8 inches.
4. Insert one foam cradle from the original shipment onto the floor of the box. (The original foam cradles are of the same type of construction and are completely interchangeable.) If the foam cradles are not available, cover the bottom and sides with no less than 3 inches of N–95 foam strips. Arrange the strips in the configuration illustrated in Figure 7-1.
5. Before sealing the carton, include the following:
   a. Statement of the problem or service needed. Be specific. Include the name and telephone number of a knowledgeable technician for consultation.
   b. The part number, serial number, return address, and purchase order number.
6. Seal the carton using gummed tape.
7. Address the carton to:

FLUKE CALIBRATION
10311 WESTPARK DRIVE
HOUSTON, TX 77042
USA

8. Label the carton with the following labels: **THIS SIDE UP, HANDLE WITH CARE, DO NOT DROP**, and **FRAGILE**. (If the original shipping carton is utilized for this shipment, the above markings are preprinted on the carton.)



gme38.bmp

Figure 7-1. Packing the ADTS

Shipping Instructions

Fluke recommends using air freight for transportation. Surface transportation subjects the shipment to more frequent handling and much more intense shock. In most cases, if surface transportation is the mode of transport employed, handling damage is likely.

Again, it is essential that the procedures mentioned in this Chapter be strictly adhered to in order to prevent any shipping and handling damage to the instrument.

Appendix A
Summary of Specifications

Uncertainty Analysis

To perform an Uncertainty Analysis on a measurement device, you must be able to identify all of the parameters that influence the measurement. You must be able to quantify the magnitude of the potential error source and combine these into an overall uncertainty statement.

To determine the expanded uncertainty on any manufacturers pressure Transfer Standard (TS), you must identify the following four primary influences;

1. Performance specifications of the TS
2. Long term Stability of TS
3. Uncertainty of the standard used to calibrate the TS
4. Environmental or installation influences that could cause errors in the TS

Performance Specifications

Performance Specifications are the short-term measurement properties of the device. These traditionally include linearity, hysteresis, and repeatability properties of the transfer standard. There often is considerable confusion with the performance specification because different manufacturers use different terms to describe the performance characteristics of their instruments. The two most common terms used are “Accuracy” and “Precision”. In both cases, as a minimum the manufacturers define these terms to be the combined effects of linearity, hysteresis and repeatability. Since the manufacturer defined the terms they used, this should not be a problem. However, it is common that the user’s definition of these terms differ from the manufacturer’s and therefore cause considerable confusion. For instance, the user may believe that the term “Accuracy” includes all sources of uncertainty. This would include items 1 through 4 listed above which would be an all encompassing specification. The manufacturer may define “Accuracy” as the performance specification which consists only of item 1 above. The result would be that the instrument would not be capable of meeting the user’s application because it would not meet the user’s definition of “Accuracy”.

Long Term Stability

Long Term Stability defines how the instrument drifts with time. This specification can be utilized to define the calibration interval for the standard. Some manufacturers will provide more than one stability specification for their instrument based on different calibration time intervals. It is important to understand that you should not arbitrarily vary the manufacturer's stability specification based on time without knowing the characteristics of their device. Some manufacturers identify that their stability specification is proportional with time. Therefore, if the calibration interval were reduced in half, the magnitude of the stability specification would also be halved. This can be a powerful tool when you are trying to improve the measurement performance of a standard. By reducing the calibration interval, the expanded uncertainty would also reduce. On the other hand, some manufacturers do not claim that their stability specification is proportional with time. This would be the case for instance if the instrument naturally drifted in a sinusoidal fashion. This would suggest that the sensor could drift to its maximum stability limit at any time and therefore, reducing the calibration interval would not improve the expanded uncertainty of the device.

Short Term Stability

Short Term Stability relates to the zero drift characteristics of the instrument. This generally is classified as short term drift since the instrument can be re-zeroed without performing a full calibration as required to correct for long term span drifts. The magnitude of zero drift can be assessed based on the length of time between re-zeroing the instrument.

Uncertainty of the Standard

Uncertainty of the Standard is used to calibrate the transfer standard. This is the expanded uncertainty of the calibration standard that was used by the manufacturer to calibrate the digital transfer standard. This should be the expanded uncertainty of the calibration standard and include all sources of uncertainty that would influence the calibration standard including the uncertainty from the National Standards Laboratory that the standard is traceable.

It should also be noted that when the instrument is re-calibrated, the uncertainty of the device is influenced by the uncertainty of the calibration standard that will be used to perform the re-calibration. Therefore, the uncertainty analysis should be evaluated following each re-calibration. If the instrument is re-calibrated using a different calibration service provider than the manufacturer, the uncertainty of the standard that the calibration service provider used to perform the calibration would need to be substituted for the manufacturers calibration uncertainty that was used in the original uncertainty analysis.

Environmental or Installation Influences

Environmental or installation influences that could cause errors in the transfer standard: This includes influences such as ambient temperature, line pressure, head pressure, time response, and controller effects. (It may include other influences that are very specific to one manufacturer's instrument.) It is recommended that the intended application is reviewed to assure that the environmental does not impact the instruments performance, or that the impact from the environment is accounted for in the uncertainty analysis. For instance, if an instrument has a 0.001% FS per °C temperature effect from a calibrated temperature of 20 °C, and the instrument is to be used in an environment where the temperature will vary from 15 °C to 25 °C, then a ± 0.005% of full scale uncertainty should be included in the uncertainty analysis for ambient temperature effects.

Absolute Zeroing Reference Sensor

The two sigma expanded uncertainty of the vacuum sensor is used to zero the absolute Ps sensor is estimated to be less than or equal to 10 mtorr (1.33 Pa) per year.

Combining the Uncertainty Components into an Expanded Uncertainty Statement

Once all of the uncertainty components are identified, they can be combined into an overall Expanded Uncertainty Statement for the instrument. The vast majority of the measurement community has adopted a statistical approach to uncertainty analysis such as the International Organization for Standards (ISO) Guild to the Expression of Uncertainty in Measurement. This statistical approach combines all of the uncertainty components in quadrature (RSS).

In this approach, it is important to define the level of confidence that all of the uncertainty components are defined. For instance, all of the uncertainty specifications that Fluke publishes are at the 2 sigma level which would be at a 95% confidence level. Some manufacturers may state their uncertainty at different confidence level and therefore, you would need to be able to convert from one to the other in order to compare the two devices. For instance, if a manufacturer states that they have an uncertainty of 0.005% FS and that the uncertainty is expressed at the 1 sigma level, then it would be doubled to express it at the 2 sigma level (i.e. it would be an 0.01% FS device at a 2 sigma or 95% confidence level.)

Controller Specification

When the system is in control mode, the control noise is defined as how close the controller can maintain the control pressure to the commanded set-point. In the active control mode, the RUSKA 7750i has a control noise specification of 0.001% of Full Scale.

In the Passive control mode, since the controller shuts off when it reaches a user-defined band about the commanded set-point, the uncertainty of the pressure measurement is not influenced by the controller.

The following tables are uncertainty analysis examples for a RUSKA 7750i based on a three-month and a yearly calibration.

Table A-1. Uncertainty Analysis for a RUSKA 7750i — 3 month and Yearly Calibration

Uncertainty Analysis — RUSKA 7750i	**90 Day Uncertainty 32 inHg Ps Sensor (2 sigma)**	**1 year Uncertainty 32 inHg Ps Sensor (2 sigma)**
A.1 Performance — (Linearity, Hysteresis, Repeatability and Temperature)	Greater of 0.005% of RDG or 0.0004 inHg	Greater of 0.005% of RDG or 0.0004 inHg
A.2 Span Stability	0.0019% of RDG/90 days	0.0075% of RDG/year
A.3 Zero Stability — (re-zero at 8 hours)	0.0004 inHg	0.0004 inHg
A.4 Calibration Standard – (Abs. Mode) (RUSKA 2465 or 2468 DWG)	0.001% RDG & 0.00039 inHg	0.001% RDG & 0.00039 inHg
A.5 Environmental —		
Temperature (Included in A.1)	0.000% of RDG	0.000% of RDG
Head Pressure (± 0.25 in)	0.0007% of RDG	0.0007% of RDG
Control — (in Passive Control)	0.000% of RDG	0.000% of RDG
A.6 Vacuum Reference Zeroing Sensor	0.00039 inHg	0.00039 inHg
A.7 Two Sigma Expanded Uncertainty	RSS (0.0055% RDG & 0.0008 inHg)	RSS (0.0091% RDG & 0.0008 inHg)

Table A-2. Uncertainty Analysis for a RUSKA 7750i — 3 month and Yearly Calibration

Uncertainty Analysis — RUSKA 7750i	**90 Day Uncertainty 40 inHg Ps Sensor (2 sigma)**	**1 year Uncertainty 40 inHg Ps Sensor (2 sigma)**
A.1 Performance — (Linearity, Hysteresis, Repeatability and Temperature)	Greater of 0.005% of RDG or 0.0005 inHg	Greater of 0.005% of RDG or 0.0005 inHg
A.2 Span Stability	0.0019% of RDG/90 days	0.0075% of RDG/year
A.3 Zero Stability — (re-zero at 8 hours)	0.0005 inHg	0.0005 inHg
A.4 Calibration Standard — (Abs. Mode) (RUSKA 2465 or 2468 DWG)	0.001% RDG & 0.00039 inHg	0.001% RDG & 0.00039 inHg
A.5 Environmental —		
Temperature (Included in A.1)	0.000% of RDG	0.000% of RDG
Head Pressure (± 0.25 in)	0.0007% of RDG	0.0007% of RDG
Control — (in Passive Control)	0.000% of RDG	0.000% of RDG
A.6 Vacuum Reference Zeroing Sensor	0.00039 inHg	0.00039 inHg
A.7 Two Sigma Expanded Uncertainty	RSS (0.0055% RDG & 0.0009 inHg)	RSS (0.0091% RDG & 0.0009 inHg)

Table A-3. Uncertainty Analysis for a RUSKA 7750i — 3 month and Yearly Calibration

Uncertainty Analysis — RUSKA 7750i	**90 Day Uncertainty 32 inHg Qc Sensor (2 sigma)**	**1 year Uncertainty 32 inHg Qc Sensor (2 sigma)**
A.1 Performance — (Linearity, Hysteresis, Repeatability and Temperature)	Greater of 0.005% of RDG or 0.0004 inHg	Greater of 0.005% of RDG or 0.0004 inHg
A.2 Span Stability	0.0019% of RDG/90 days	0.0075% of RDG/year
A.3 Zero Stability — (re-zero at 8 hours)	0.0004 inHg	0.0004 inHg
A.4 Calibration Standard — (RUSKA 2465 or 2468 DWG)	Greater of 0.0010% RDG or 0.00002 inHg	Greater of 0.0010% RDG or 0.00002 inHg
A.5 Environmental —		
Temperature (Included in A.1)	0.000% of RDG	0.000% of RDG
Head Pressure (± 0.25 in)	0.0007% of RDG	0.0007% of RDG
Control — (in Passive Control)	0.000% of RDG	0.000% of RDG
A.6 Vacuum Reference Zeroing Sensor	0.000 inHg	0.000 inHg
A.7 Two Sigma Expanded Uncertainty	RSS (0.0055% RDG & 0.0007 inHg)	RSS (0.0091% RDG & 0.0007 inHg)

Table A-4. Uncertainty Analysis for a RUSKA 7750i — 3 month and Yearly Calibration

Uncertainty Analysis — RUSKA 7750i	**90 Day Uncertainty 68 inHg Qc Sensor (2 sigma)**	**1 year Uncertainty 68 inHg Qc Sensor (2 sigma)**
A.1 Performance — (Linearity, Hysteresis, Repeatability and Temperature)	Greater of 0.005% of RDG or 0.00085 inHg	Greater of 0.005% of RDG or 0.00085 inHg
A.2 Span Stability	0.0019% of RDG/90 days	0.0075% of RDG/year
A.3 Zero Stability — (re-zero at 8 hours)	0.0009 inHg	0.0009 inHg
A.4 Calibration Standard — (RUSKA 2465 or 2468 DWG)	Greater of 0.0010% RDG or 0.00002 inHg	Greater of 0.0010% RDG or 0.00002 inHg
A.5 Environmental —		
Temperature (Included in A.1)	0.000% of RDG	0.000% of RDG
Head Pressure (± 0.25 in)	0.0007% of RDG	0.0007% of RDG
Control — (in Passive Control)	0.000% of RDG	0.000% of RDG
A.6 Vacuum Reference Zeroing Sensor	0.000 inHg	0.000 inHg
A.7 Two Sigma Expanded Uncertainty	RSS (0.0055% RDG & 0.0012 inHg)	RSS (0.0091% RDG & 0.0012 inHg)

Specifications

General Specifications

Pressure Range:	Standard available ranges; Ps: 32 inHg Abs. (0 to 1085 mbar Abs.) or, 40 inHg Abs. (0 to 1355 mbar Abs.) Qc: 32 inHg Diff. (0 to 1085 mbar Diff.) or, 68 inHg Diff. (0 to 2300 mbar Diff.)
Internal Volume:	Ps: 24 ± 1 in^3 Qc: 1.8 ± 0.3 in^3
Custom Ranges:	Consult Factory
Display:	6.4 inch, TFT Active Matrix Color
Display Resolution:	1 ft; 0.1 m; 0.1 km/h; 0.1 knots; 0.00001 Mach
Electrical Power:	100 – 120 VAC, 220 – 240, VAC 50/50 Hz, 150 W max.
Operating Temperature:	18 °C to 36 °C
Storage Temperature:	–20 °C to 70 °C
Humidity:	5% to 95% relative humidity, non-condensing
	Nominal Control Volume: 5 to 60 in^3 (80 to 1000 cm^3)
Dimensions:	7 in H x 16.5 in W x 19 in D (17.8 cm x 41.9 cm x 48.3 cm)
Weight:	45 lb (20 kg)
Standard Pressure Units:	Engineering Units: inHg at 0 °C and 60 °F, kPa, bar, psi, inH_2O at 4 °C, and 25 °C, kg/cm2, mmHg at 0 °C, cmHg at 0 °C, and cmH_2O at 4 °C & two user defined linear units of measure.
	Aeronautical Units: feet, meters, knots, km/h, Mach
Pneumatic Ports:	1/4 inch NPT female, with AN4 & AN6 adapters supplied.
Relief Valves:	Test Port: 120% of Maximum Scaled Quartz Sensor Range
Supply Pressure:	60 psi ± 5 psi (4 bar ± 0.5 bar)
Supply Vacuum:	Minimum 50 liters per minute with auto vent feature, Ultimate vacuum less than 1 mtorr.
Ingress Protection:	IP-20, Indoor use, Altitude <2000 in
EMC:	EN 61326
Electrical Safety:	EN 61010
Pressure Safety:	Pressure Equipment Directive 97/23/EC-class, Sound Engineering Practice (SEP)
Interface:	IEEE 488 and RS232

Gas Specifications

Pressure Source Medium: Clean Dry Air or Industrial Grade Nitrogen, 99.5% pure

Pressure Source Particle Size Contamination: ≤ 50 microns

Pressure Source Max. Moisture Content: -50 °C dew point

Pressure Source Max. Hydrocarbon Content: 30 ppm

Table A-5. Specifications RUSKA 7750i

	Ps		
Mode	Absolute		
Precision[1]	From 25% to 100% of FS: 0.005% of Reading Below 25% FS: 0.005% of 25% FS		
Stability; Over 3 Months: Over 1 Year:	0.0019% RDG/ 3 months 0.0075% RDG/year		
Zeroing Vacuum Sensor	± 10 mtorr at = 100 mtorr, ± 10% RDG at > 100 mtorr		
Active Control Stability	0.001% FS		
Control Low Limit[2]	0.3 inHg a (10 mbar a)		
Zero Drift[3]	<0.002% FS / 24 hrs		
Standard Load Volume	5 to 60 in^3 (80 – 1000 cm^3)		
Total Uncertainty[4] (Aeronautical Units)	32 inHg a Sea Level ± 2 ft 30,000 ± 2 ft 60,000 ± 7 ft	40 inHg a Sea Level ± 2 ft 30,000 ± 3 ft 60,000 ± 8 ft	100 inHg a Sea Level ± 3 ft 30,000 ± 4 ft 60,000 ± 15 ft
Total Uncertainty[4] (Engineering Units)	32 inHg a 5 ± 0.0008 inHg 15 ± 0.0013 inHg 30 ± 0.0025 inHg 32 ± 0.0030 inHg	40 inHg a 5 ± 0.0009 inHg 15 ± 0.0014 inHg 30 ± 0.0026 inHg 40 ± 0.0037 inHg	100 inHg a 5 ± 0.0016 inHg 15 ± 0.0019 inHg 30 ± 0.0028 inHg 50 ± 0.0046 inHg 100 ± 0.0092 inHg
Rate of Climb	0 to 6,000 ft/min.		
Rate of Climb Tolerance	1% of commanded rate for altitudes up to 50,000 ft 5% of Commanded Rate for altitudes from 50,000 ft to 70,000 ft		

[1] Precision is defined as the combined effect of linearity, repeatability, and hysteresis throughout the operating temperature range. Some manufacturers use the word “Accuracy” in place of “Precision”, however the meaning is identical.

[2] Requires vacuum pump to control 0 psig, or the vent mode can be used to obtain 0 psig.

[3] Zero drift typically improves with sensor age.

[4] Total Uncertainty is defined as the two sigma combined uncertainty of linearity, hysteresis, repeatability, thermal effects one year drift stability and the uncertainty in the Fluke primary standard, which include the uncertainty from NIST.

[5] The controller will control rates greater than 6000 ft/min, but its ability to do so is not covered by the Rate of Climb Tolerance specification.

Table A-6. Specifications RUSKA 7750i

	Qc	
Mode	Differential	
Precision[1]	From 25% to 100% of FS: 0.005% of Reading Below 25% FS: 0.005% of 25% FS	
Stability; Over 3 Months: Over 1 Year:	0.0019% RDG/ 3 months 0.0075% RDG/year	
Zeroing Vacuum Sensor	N/A	
Active Control Stability	0.001% FS	
Control Low Limit[2]	0 inHg D (0 mbar D)	
Zero Drift[3]	<0.002% FS / 24 hrs	
Standard Load Volume	5 to 60 in^3 (80 – 1000 cm^3)	
Total Uncertainty[4] (Aeronautical Units)	32 inHg D 50 ± 0.1 knots 100 ± 0.05 knots 250 ± 0.02 knots	68 inHg D 50 ± 0.2 knots 250 ± 0.04 knots 500 ± 0.02 knots 1000 ± 0.02 knots
Total Uncertainty[4] (Engineering Units)	32 inHg D 0.5 ± 0.0005 inHg 16 ± 0.0013 inHg 32 ± 0.0026 inHg	68 inHg D 0.5 ± 0.001 inHg 16 ± 0.0016 inHg 32 ± 0.0027 inHg 68 ± 0.0055 inHg

[1] Precision is defined as the combined effect of linearity, repeatability, and hysteresis throughout the operating temperature range. Some manufacturers use the word “Accuracy” in place of “Precision”, however the meaning is identical.

[2] Requires vacuum pump to control 0 psig, or the vent mode can be used to obtain 0 psig.

[3] Zero drift typically improves with sensor age.

[4] Total Uncertainty is defined as the two sigma combined uncertainty of linearity, hysteresis, repeatability, thermal effects one year drift stability and the uncertainty in the Fluke primary standard, which include the uncertainty from NIST.

Appendix B
Summary of Error Messages

Summary of Error Messages

Negative error numbers are from the Standard Commands for Programmable Instruments (Version 1991.0).

Table B-1. Summary of Error Messages

Value	Description and Corrective Action
0	No Error.
-103	Invalid Separator. Check punctuation in the SCPI command.
-104	Data Type. The type of parameter data is incorrect.
-109	Missing Parameter. No valid parameter was found for the SCPI command.
-110	Command Header. The command name is not valid.
-113	Command Unknown. The command specified does not exist.
-114	Header Suffix. The numeric suffix for the command name is out of range.
-201	Remote Required.
-221	Settings Conflict. The command could not be executed due to the current state of the ADTS. Some commands cannot be executed while a program, self-test, or calibration is in progress.
-222	Out of Range. The value is not within the valid range. For pressures check high and low limits.
-281	Cannot Create Program. Program memory is full.
-282	Illegal Program Name. The name specified is not valid or does not exist.
-284	Program Currently Running. The command cannot be executed while a program is running.
-285	Program Syntax Error. The syntax of the program definition is not correct.
-286	Program Runtime Error. An error occurred while running the program. Usually the set point is out of range.
-313	Calibration Data Lost. The calibration data has been lost and the unit must be recalibrated.
-315	Configuration Data Lost. The configuration data has been lost. Check all parameters to be sure they are correct.

Table B-2. Summary of Error Messages, continued

Value	Description and Corrective Action
-330	Self-Test Failed. Check the display for the test that failed.
-350	Queue Overflow. The error queue was full and messages were lost.
-400	Query error. A read request was received when there was nothing to read.
500	Controller Malfunction. Internal control failure.
501	High Limit Exceeded. The pressure was greater than the high limit.
502	Low Limit Exceeded. The pressure was less than the low limit.
503	Slew Limit Exceeded. The pressure changed faster than the slew limit allowed.
504	Negative Qc Limit Exceeded.
505	ARINC Limits Exceeded.
521	Pressure Over Range. The pressure reading is outside the range of the DPC.
531	Oven Temp Over Range. Either the transistor that drives the heater for the quartz bourdon tube sensor, or the oven temperature sensor itself is malfunctioning. To observe the oven temperature, select OK the select MENU/DISP. Check the transistor and sensor for malfunction, requesting service if necessary.
532	Vacuum Sensor Over Range.
533	Case Pressure Over Range. Select OK, then reduce the pressure at the case reference port to 30 psia or lower.
538	Automatic Vent.
540	Mechanical Zeroing Needed. The zero point of the quartz bourdon tube sensor is beyond the range of the compensation circuit. The zero is adjusted by the software, but should be manually adjusted for complete accuracy.
542	Oven Control Failure. The temperature controller is unable to keep the sensor at the proper temperature.
545	Sensor Communication Error. Unable to communicate with sensor.
546	Sensor Calibration Lost. The sensor has lost its calibration, and must be recalibrated.
550	Zero Aborted. Zeroing has been aborted by local or remote.
600	Factory Data Lost. Internal factory constants have been lost. Contact Fluke for more information.
601	Calibration Mode. The calibrate button must be pressed before SCPI calibration commands can be executed.
602	Model Changed. Clear Memory? The downloaded update does not match the installed software. DO NOT CLEAR this error. Download the correct software.
603	Waiting for Calibration. The previous calibration point has not completed.
707	Pressure Too High.
708	Cannot Calibrate in Pt Mode. The Qc sensor cannot be calibrated in Pt (Absolute) mode. It must be calibrated in Qc (Differential) mode.
800	Solenoid Over-Temperature. The control solenoids have over-heated. Wait until they have cooled before entering Control mode.

Table B-3. Summary of Error Messages, continued

Value	Description and Corrective Action
801	Error Reading Barometric RPT Pressure Sensor.
802	Control Sensor Out of Range.
803	Controller Communication Error.
804	Auto-Tune Failed.